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The Water Board as a Factor in Good Management

By Henry S. Nollen

THE author, in this paper, will present a specific example of municipal ownership and management and point out its particular benefits and efficiencies. He recognizes that a variety of methods of control are practiced in other such public utilities, but at this time does not intend to discuss their relative merits.

Inasmuch as water is manifestly an essential of life for which there is no substitute, its supply in a growing municipality is most naturally regarded as properly subject to public control. About 22 years ago the doctrine of municipal ownership had gained sufficient public support in Des Moines to introduce the water plant as a political issue. Because of the strength of the support, it was felt that the purchase of the water plant by the City would be approved by a large majority of the voters.

To forestall any hastily planned scheme, however, a group of civic-minded men, representing various business interests, met to discuss methods by which the water plant might be assured an efficient, business-like administration under municipal ownership. With the cooperation of the incumbent city attorney, a strong advocate of public ownership, they framed mutually acceptable provisions which were incorporated into the city ordinances, and later into the state statute enacted specifically to authorize the purchase and adminis-

A paper presented on April 24, 1940, at the Kansas City Convention by Henry S. Nollen, Chairman, Board of Water Works Trustees, Des Moines, Iowa.

tration as planned. The chief concern was to create an administrative body removed as far as possible from the pressure of politics. To this end, the suggestion that a board be appointed by judges of the district court was rejected in favor of placing responsibility with the city council, a body composed of five members elected for concurrent two-year terms. Further stipulations provided that appointments be made by the mayor, subject to approval by a majority of the council, and that compensation be fixed at $50 per month for each trustee.

Under this authority a board of five trustees was selected, appointed for initial staggered terms of two, four, and six years, and subsequent six year terms. This system of appointments was designed to permit greater stability in administrative policy and to aid in removing the choice of personnel from political domination.

A further protective feature in making the board independent in action is the statutory provision that, "No person shall be eligible for appointment on the board while he holds or is a candidate for, or has within one year held, any other salaried civil, federal, state, county or city office or position."

The first board, appointed in September, 1919, was composed of the manager of a department store, an educator and former mayor, a representative of the unions, a prominent coal dealer, and a life insurance company official. It was expected that such a body of men would, through the variety of its combined experience, form a broad view of the needs of the community and best serve its interests. Through a common purpose to form and conduct an organization which would furnish the community with an ample supply of the purest water available at the lowest possible cost and with impartial treatment of every group and individual, the board measured up to all expectations. In its meetings it considered and adopted those general principles designed to govern the conduct of all the various angles of the plant's business.

From the beginning the board has enjoyed marked public favor. It is a satisfaction to report that during the twenty-year period, regardless of change in personnel, the members have worked in harmony and toward a common purpose of efficiency. Two members served until their deaths, one for over 11 years, another for nearly 18. The chairman is the only remaining member of the original board and he has served continuously except for a recent two-year interval.

The question of public relations presented an immediate problem inasmuch as the transfer from private to public ownership had to be made with no interruption in service. Some question arose as to whether individuals who had operated the private utility were fitted by temperament to serve a municipally owned utility. Since a private enterprise depends quite as much upon public favor as does a municipal body, however, and since it is practically a universal custom among all private enterprises to appeal for patronage not only through efficient service but in courtesy, it was felt that no difficulty would arise from this source.

Previous Management Retained Under Municipal Ownership

The private plant had, for many years, been under the management of Mr. Charles S. Denman. It was apparent that, if service were to be uninterrupted, he and his staff must be retained, at least temporarily. This, it was felt, would also be a real test of the suitability of the original personnel. At the same time a committee was appointed to inquire into the availability of a manager who could in every respect meet Mr. Denman's technical qualifications. Investigation soon convinced the committee of the value of Mr. Denman's service and assured them that replacing him with a lower-salaried substitute would be false economy.

Mr. Denman's death some time later occasioned another search for a manager. It was a tribute to his organizing ability that by far the best qualified applicant came from his own personnel. The state law was framed to contain a provision prohibiting any member of the city council, by solicitation or otherwise, to exert his influence directly or indirectly on the Board of Water Works Trustees, or any member thereof, in the hiring or discharging of any employee or employees. With the complete responsibility for selection in its hands the board felt none of the political pressure which might have been exerted had an elective body been given jurisdiction in the matter.

The board, in meeting its statutory powers of supervision over and responsibility for all details of administration and operation, has placed in the plant manager responsibility for the selection and supervision of all employees and assignment of their duties. It has been the policy of every member to give the manager freedom in his action by avoiding any demands for favors in the appointments to be made. Experience has demonstrated the wisdom of this arrangement.

The entire staff has demonstrated a remarkable degree of loyalty and a readiness to meet all emergencies. Humanitarian policies have characterized the treatment of all employees not only in regard to wages but in giving consideration for illness and accident. All of these policies have resulted in a marked permanence in personnel, as evidenced by the fact that the average tenure of the 135 regular employees is almost 14 years—15 terms extending from 20 to 57 years of service. Obviously this has contributed greatly to the efficiency of operation.

The board is required by law to keep its accounts distinct and separate from other city accounts in such a manner as to show the true and complete financial results of operation. It must also maintain an approved system of accounting, with requisitions showing the purchase, storage and use of materials for operation, construction and other purposes. In this way the board is made responsible for the purchase of all supplies.

Purchasing on an Impartial Basis

From the outset the board adopted a purchasing policy, pursued by successful private enterprises, of considering price and quality on a strictly impartial basis. At the time it was the custom of salesmen to undertake contacting members of the board in connection with any bids they proposed to make. In each case the bidders were referred to the manager who required them to place their propositions in writing for consideration at a general meeting of the members. This practice was found particularly appropriate shortly after the acquisition of the plant when the board was confronted with the necessity of constructing a new pumping station, installing new pumping equipment, and constructing new suction wells and various buildings to modernize the plant. All the actual arrangements for this physical reorganization were made under the direction of the consulting engineers and the manager, but final decisions were subject to approval by the board. It is interesting to note that in one instance a salesman, discovering that it was futile to contact members of the board for preference, finally went to the manager and asked to revise his bid. Regardless of changes in personnel the same policy has been adhered to throughout the board's administration.

In this connection the author is confident that at no time has any member of the board or any employee received a gratuity from any person or organization interested in the sale of equipment, supplies

or other merchandise. He also feels that under the plan of taking bids in which not only price but quality and suitability for use are considered, the plant has received full value in all transactions. Ample cash available to discount all bills has also favored purchases at advantageous figures. The manager is, of course, authorized to purchase essential supplies in moderate amount without previous board approval.

Sanitary Control Effected

Because of the soil formation peculiar to the locality, i.e. glacial sand and gravel extending along the river bank in which the collecting system is laid, it is especially necessary that this entire area be protected against pollution. The board has had to prevent the sale of certain privately owned areas to an industrial concern which would have endangered the sanitary safeness of the watershed. After this same purpose, through direct purchase or condemnation proceedings, the board has acquired ownership of approximately 1,500 acres, which, located along the Raccoon River, drains a watershed of more than 4,000 square miles and is the principal source of supply. Periodical consideration has been given the problem with a view toward anticipating future needs and emergencies which must be provided for in advance.

Included in the powers and duties of the board is that of determining all questions of engineering, mechanical and operating details, and extensions of mains and other plant facilities and improvements. By special provision the board is required to "establish" such rules regarding the extension of mains as, in its belief, will inure to the greatest benefit of the city. Also it must *avoid granting special favors* in the extension of mains by requiring property owners, when necessary, to make certain guarantees or to pay certain sums to cover the cost of unprofitable extensions. The one exception is that upon the passage of any ordinance or resolution by the city council ordering any street improvement or sewer installation where a water main should be laid or extended *prior* to such improvement, written notice of the action must be given to the board. Upon receipt of such notice the board, with no unnecessary delay, must have mains laid or extended in the streets affected by the resolution or ordinance.

As was to be expected under municipal control, there occurred a wide-spread demand for extension of service. In dealing with the human factors involved, it was fortunate for the board, in preserving

the economic status of the plant, that legal requirements made it necessary to consider the prospective returns before incurring the cost of extending any specific service. All pleas to the city council for extensions were automatically referred to the board, and it, in turn, before consideration, required that the property owners and residents affected sign a petition which recorded their intention to make connection to the proposed mains. On the basis of these promises the board could make an estimate of prospective revenues. In certain areas where new additions were being promoted, the board required deposits of a sufficient sum to warrant the outlay for the extensions to be made—in some cases the full cost was exacted, credit being given to apply in the payment of future water bills.

Des Moines has an area of 55 square miles and a population of approximately 150,000. These figures are indicative of the very sparse settlement in certain sections and the consequently high cost of the required distribution system. Actually 55 per cent of the entire value of plant property is represented in the distribution system. In the 20 years of municipal ownership its value has been increased about 90 per cent while the population increase has been only about 20 per cent.

Policy of Main Extension

In the matter of extension of mains, the board gave due consideration to the question of public health, regardless of revenue. While the public had been well protected against water-borne diseases through the purity of its water supply, a considerable number of residents were still relying upon private wells which in some cases were unsanitary. For this reason the board considered it a moral obligation to make the service as widely available as possible. That the purpose has been largely accomplished is indicated by the fact that of the possible 39,000 connections in the city only 1,563 do not have access to water mains, and these are chiefly in outlying districts which are still open country and not readily subject to pollution. There are approximately 35,000 consumers within city limits, but upon the mained streets there are still 2,343 houses which have not connected, primarily because the character of the soil makes the driving of sand points easy. The health authorities are making a strenuous effort to compel all of these properties to connect with the readily accessible mains, and without a doubt the delay has been caused, in great part, by adverse economic conditions. The board

itself has no power to compel a property owner to make a service connection with a main in front of his property.

The public health factor has also led the board to include in the areas served those communities adjacent to, but outside, city limits. As a civic body, of course, the board was obligated to consider the extent to which denial of the benefits of a water system might discourage building in the lower tax areas outside city limits, but inasmuch as its own gain, through lower average cost of operation and better health protection within the city, was deemed of more importance, the areas were included. Considerations in the decision included such factors as the unquestionable ampleness of the supply, the substantially higher rates to non-residents, and the fact that sanitary supply in the areas was of vital importance to the health of the whole community.

Management of Revenue and Finances

Bond issues provided funds for the original purchase of the plant and the subsequent improvements and extensions, but all of these were, under statute, to be paid for from plant revenue. Accordingly, the board was authorized to fix rates to consumers and to the city which were to be sufficient to cover:

(1) Interest on the entire outstanding indebtedness, including that portion which was a general obligation against the city.
(2) Cost of all operating expenses, including legal liability on judgments.
(3) A sufficient depreciation fund to cover such repairs and replacements as may properly be charged against such fund.
(4) A sufficient annual provision for a sinking fund to pay at maturity all bonds and certificates and certain other stated obligations.
(5) A surplus, up to $125,000, to be used as a working capital.

Municipally owned, the plant pays no general property tax, but special assessments are levied against it on the same basis as on private property.

In assuming control, the board adopted and authorized continuation of the various water rates which had been in effect under the private management and which had been approved by the courts within the year. The only change was the elimination of all free water service. Since then, the same schedule of rates has remained in effect with only slight modification except for the elimination of

the so-called meter or service charge of $2 per meter per year. This fee had caused increasing discontent in that it was charged regardless of consumption and in addition to regular payments. Its elimination was felt justified as a concession to public policy and since a minimum charge of $1 per quarter per meter was retained the loss in revenue was not controlling.

In addition to its regular rate making, the board is required to fix rates to be paid by the city for public use with the one limitation that such annual rental or rate is not to exceed $350 per mile of main, at least six inches in size, in operation. Under pressure of the financial status of the city, this charge became a point of difficulty. In consequence of the depression, the city council had for some years been under pressure from certain property interests to keep levies down in spite of the increasing public relief burdens incurred. Accordingly these property owners encouraged the council to apportion, arbitrarily, only half of the amount required to pay the city water bills. Inasmuch as the financial condition of the plant was excellent, its ample sinking fund appeared to be an attractive point of attack. About three years ago, however, under its authority to sue and be sued, the board won a suit against the city and received judgment for the full amount of unpaid water bills. Subsequently because of continued distress in city finances, the board entered into an agreement under which peace and harmony now prevail. All has not been smooth sailing, but through sound legal counsel the safety of the financial structure has been maintained.

The various financial transactions of the board are an interesting study. Original cost and outlay was $3,500,000 and additions and improvements amounted to $5,250,000, making a total expense of $8,750,000. Various bond issues total $5,718,000, of which $1,540,000 have been retired out of plant revenue, leaving a balance of $4,178,000 of bonds outstanding. Total revenue during the twenty-year period was in excess of $15,830,000; operating expenses, $5,600,000; interest paid on indebtedness, $4,900,000; leaving a net income of $5,330,000, of which $4,570,000 is invested in the plant and the remainder held in a sinking fund and various reserves. Depreciation charges have totaled over $2,000,000, leaving net worth about $6,700,000.

Frequent reference has been made to legal regulations governing the details of legislation. With the enactment of the state law, under which the purchase was authorized, provision was also made to safe-

guard a permanent business-like administration by the incorporation of these various regulations. The business men's committee, previously referred to, felt that incorporation in state, rather than local, legislation would assure a greater permanence to these necessary rules. In this manner through legal provision and in addition through all the various policies instituted over the twenty-year period, the management through the board has been maintained on an efficient basis.

Discussion by *W. W. Hurlbut.* * The original Board of Water Commissioners for the City of Los Angeles was composed of seven men. Later on, when the city charter was revised, it became the Board of Water and Power Commissioners, with five members, each serving five years. The Department is comprised of two bureaus, the Bureau of Water Works and Supply and the Bureau of Power and Light, and each bureau is administered by a Chief Engineer and General Manager reporting directly to the Board of Water and Power Commissioners. The commissioners' terms of office are so arranged that a new Board member is appointed each July 1. In this way, a commission is created in which there are always members who are familiar with the business of the Department.

Normally, it has been a non-political board. There have been some political boards, but political appointments are embarrassing to the management. There have been controversies, but fortunately one hundred per cent of the two thousand employees of the Water Bureau of the Department are under civil service. They can be appointed only from civil service lists in their respective classifications, under competitive examinations; and temporary appointments can be made for a period of only sixty days (not subject to renewal), except in the case of construction jobs, when emergency appointments may be made for the duration of the job only.

The entire personnel of the Department functions directly under the jurisdiction of the General Managers. Wage and salary adjustments are submitted by the Managers to the Commission for approval, and the wage and salary schedule of the Department of Water and Power has no connection whatever with the wage and salary schedule of the balance of the City Government.

The Commission handles its own funds. The total investment of

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the plant under the jurisdiction of the Board of Water and Power Commissioners is $425,000,000, of which approximately $200,000,000 is water and the balance power. The Water Revenue Fund is set aside as a separate entity, and the same applies to the Power Revenue Fund.

Many times, controversial conditions arise which bring the Water Bureau into conflict with other City departments. It is a great assistance to the water works management to be able to go to the Board and recommend that certain procedures be followed in relation to inter-City department business, thus making it a Board matter.

All purchases are made in accordance with specifications and by advertisements calling for bids. Sealed bid proposals are opened and the Board in all cases accepts the recommendation of the General Manager. It is not always the low bid, but the lowest ultimate cost to the Department based on engineering judgment and experience, which is the main guide in connection with the award of such contracts. No commissioner, under the laws of the State of California and under our own charter provisions, can vote in connection with the award of a contract if he holds more than $1\frac{1}{2}$ per cent of the capital stock of the successful bidder.

The Board of Water and Power Commissioners has the sole right of establishing the rates for the utility. The charter provides that every two years those rates must be reviewed and re-established. The common council receives that recommendation and it is obligatory upon that council to approve or disapprove the rate change or the ordinance. If the council does not approve the recommendation of the Commission, the old rates continue in force. The City Council itself cannot modify the rate ordinance.

No moneys of the Water Revenue Fund or the Power Revenue Fund can be used for any other purpose than for the extension, betterment, and improvement of the water and power systems, and it is obligatory for the Department to take care of all fixed charges on outstanding bond issues for water and power purposes. The Department pays taxes on all property outside the city limits. The utility extends over three hundred miles east and three hundred miles north. It goes through several counties and the Department pays taxes to all counties outside the city of Los Angeles just the same as any other corporation. However, the Department does transfer funds to the Social Service Commission for charitable purposes, which must come back to the Department in the form of water rates that are paid for

as far back as the institutions are concerned. There are certain other donations along this category.

The term of the commissioners over the history and formation of the Department has extended from a minimum of a few months in some cases up to a maximum of twenty-one years. The average commissioner, historically, has served about five years, just about the term of the appointment.

The personnel of the Commission is generally composed of outstanding business men of this community. At the present time we have one engineer, one industrialist, one banker, one retired steel man, and one attorney. It is a very well balanced Commission. There is no compensation. The charter provides that each commissioner shall receive five dollars for each meeting, not to exceed ten meetings a month.

The Commission itself has always been very much interested in the employee group as a whole and was probably the most active unit in connection with the recent retirement, disability, and death benefit insurance plan which went into effect a year ago last October. All employees of the Department of Water and Power had the right to elect to come in or stay out. Ninety-six per cent of those eligible to come in did so. From the time of its initiation and adoption, it has been compulsory for all new employees to become members of that plan. After six months, such new employees pass their probationary period and are definitely in the plan, provided they have passed the medical standards.

The experience in Los Angeles has been that the Water Board is a real asset to management in connection with the functioning of the Department of Water and Power.

Discussion by *George J. Rohan.* * A Board of Water Commissioners governs and manages the water department of the City of Waco, Texas, which has a population of 60,000. The system was purchased by the city from a private company in 1904, by means of a bond issue, and the present form of control has been employed since that time.

The Board consists of five members, two elected in the even years and three in the odd years, each for a term of two years. There is no compensation; however, the first president served for nineteen

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years, and the present president has served for twelve. Four of the present members are serving their sixth terms and one is serving his fifth. They are all business and professional men.

The same long term of service rule applies to the employees. The forty-one regular employees of the department have served a total of 641 years.

The Commission is as divorced from politics as possible. During the past ten years, there has been but one example of political opposition. At that time, three commissioners were up for reelection and were elected six to one over the opposition. It would appear that the Waco public is behind the Commission and the way it has handled its job.

Funds may not be diverted. The Board of Water Commissioners is supreme in handling all the affairs of the water department, setting and adjusting rates, purchasing supplies, and so forth. The four and a half million dollar plant and the distribution system are in excellent shape. A million and a half of this capitalization has been paid from revenues and the balance from a bond issue. The principal requirements of bonds are paid from ad valorem taxes and the water department is burdened only with the interest requirements of the bonds. A rather large improvement program has been handled throughout the years from revenues and without issuing bonds, and the extensions have been planned and carried out without interference. The Waco City Water Works has a substantial working capital and the lowest water rate in the State of Texas, with the exception of the City of San Antonio, which does not treat or filter its water. It is notable, however, that the Water Department of the City of San Antonio is also under the control and management of a Board of Water Commissioners.

A Statement of Municipal Policy

MAYOR Fletcher Bowron of Los Angeles, in a recent radio address outlined his own policy and that of the city's Board of Water and Power Commissioners. In that address certain statements appear which are in many ways an ideal platform of public policy in the management of municipal utilities. They are quoted herewith in order to promote a wider recognition of the principles which should motivate the directors of every public water supply system. The Mayor said (in part):

"I have gained a knowledge of the Board's ideas about the functions of the Department of Water and Power. These may be simply stated as follows:

"That the splendid water and electric plants owned by the people . . . shall be operated with the highest practicable degree of efficiency and economy; that all of the rights of the city be zealously protected; that in all matters the true interests of the consumer (who in this case is also part owner of the business) be considered and served.

"The other part of the policy of the present commissioners has to do with employee relationship, which is second only in importance to the paramount rights and interests of the public. Here I find a friendly confidence in the department personnel as a whole; the determination that the rights and all proper privileges of employees shall be maintained; that ability, merit, and dependability shall be recognized and rewarded; that laziness, insubordination, and disloyalty shall not be condoned or even tolerated; that full measure of support and encouragement be continuously accorded to the Employees' Retirement Plan, to health conserving programs, to recreational and social activities; that there is no place anywhere in the department for favoritism, preferential treatment, cliques, or petty politics; and—finally—that no one for a moment should forget, be he commissioner, executive, or minor employee, that the Los Angeles Department of Water and Power operates for no individual or set of individuals, in or out of the department, but for the use and benefit of the whole public whom it serves."

The Public Service Commission and Plant Management

By Robert A. Nixon

THE work of the Wisconsin Public Service Commission touches practically all phases of water plant management. Hence, to portray the part played by the Commission in this field requires a review of most phases of management. A few general summaries may indicate managerial activities which are affected by Commission work:

(1) *Management organizations:* The Commission has helped to establish more efficient management organizations.

(2) *Financing:* Although it has no direct supervision over the financing of municipal water utilities, the Commission has given invaluable aid in this field through its findings of feasibility; its authorizations for new plants, additions, or extensions; and its approval and development of plant plans.

(3) *Accounting:* The Commission has enabled those responsible for water plant management to obtain more accurate and useful data essential for successful operation by its accounting regulations and its auditing suggestions.

(4) *Legal advice:* Upon request, the Commission has furnished legal advice and assistance to municipal authorities, water plant officials, and attorneys.

(5) *Service and efficiency:* By its supervision, the Commission has helped to standardize service and to make operations more efficient.

(6) *Rates:* Commission regulation of rates has largely eliminated discrimination in service charges.

(7) *Complaints:* Serving as a buffer or arbiter, the Commission has assisted in resolving many local political controversies and in settling many complaints affecting municipal water plants.

A paper presented on April 24, 1940, at the Kansas City Convention by Robert A. Nixon, Commissioner, Public Service Commission of Wisconsin.

The distinctive feature of the public utilities law of Wisconsin is that it gives the Public Service Commission supervision over *all* municipal utilities, *including* water plants:

"Section 196.01. Definitions. (1) As used in chapters 196 and 197, unless the context requires otherwise, 'public utility' means and embraces every corporation, company, individual, association, their lessees, trustees or receivers appointed by any court, and every town, village or city that may own, operate, manage or control any toll bridge or any plant or equipment or any part of a plant or equipment, within the state, for the conveyance of telephone messages or for the production, transmission, delivery or furnishing of heat, light, water or power either directly or indirectly to or for the public. No co-operative association organized under chapter 185 for the purpose of producing or furnishing heat, light, power or water to its members only shall be deemed a public utility under this definition.

"Section 196.02. Commission's powers. (1) The commission is vested with power and jurisdiction to supervise and regulate every public utility in this state, and to do all things necessary and convenient in the exercise of such power and jurisdiction.

"Section 196.02. (4) (a) The commission shall have authority to inquire into the management of the business of all public utilities, and shall keep itself informed as to the manner and method in which the same is conducted, and may obtain from any public utility all necessary information to enable the commission to perform its duties."

The wisdom of this policy is now seldom questioned.

There are 323 water utilities in Wisconsin with about a dozen small plants under construction. Of the plants operating or being constructed, only 17 were under private ownership on December 1, 1939.

Because nearly 95 per cent of the water utilities in Wisconsin are municipally owned, the Public Service Commission's part in water plant management deals primarily with the management of municipally owned undertakings.

Management Organization

During the early years of state regulation the management of municipally owned water utilities was found to be rather inefficient. Water utilities were sometimes administered by superintendents, at other times by city engineers, and in still other cases by boards of

public works, commissions, or committees composed of members of common councils. Frequently it was difficult to ascertain just what the responsibilities of these various officers were and where their duties began or ended.

A striking illustration is afforded by the situation which existed until recently in one of the larger cities of the state. Theoretically the management of this water plant was in charge of a board of public works composed of the city engineer, the city attorney, and the city comptroller. Actually the city council passed upon all bills, a clerk in the board of public works office kept the books, the chief engineer of the pumping station supervised that phase of plant operation, and another employee of the board of public works supervised the operation and maintenance of the distribution plant and sewer system. These diverse responsibilities arose under the provisions of a so-called charter or home-rule ordinance. The Commission strongly urged the board of public works to take active charge of the details of operation, to appoint a general water plant superintendent, to legalize the accounting for these various activities in accordance with the Commission's uniform system of accounts, and to centralize the responsibilities therefor in the city comptroller. Most of these changes are now being made and marked improvement in the records for the guidance of the management is apparent.

Municipal water utilities in Wisconsin are managed by independent non-partisan commissions appointed by the common councils in cities of the first and second class. In cities of the third or fourth class these utilities may be managed either by a board of public works or by a non-partisan commission:

"Section 66.06 (10) (a) In cities owning a public utility, the council shall and in towns and villages owning a public utility the board may provide for a non-partisan management thereof, and create for each or all such utilities, a board of three or five or seven commissioners, to take entire charge and management of such utility, to appoint a manager and fix his compensation, and to supervise the operation of the utility under the general control and supervision of the board or council.

"(b) The commissioners shall be elected by the board or council for a term, beginning on the first day of October, of as many years as there are commissioners, except that the terms of the commissioners first elected shall expire successively one each year on each succeeding first day of October.

"(c) The commissioners shall choose from among their number a president and a secretary. They may command the services of the city engineer and may employ and fix the compensation of such subordinates as shall be necessary. They may make rules for their own proceedings and for the government of their department. They shall keep books of account, in the manner and form prescribed by the public service commission, which shall be open to the public.

"(g) In cities of the third or fourth class the council may provide for the operation of a public utility or utilities by the board of public works, in lieu of the commission above provided for."

The Public Service Commission has repeatedly advocated management by independent non-partisan commissions, and it has been shown that water plants so managed are generally more successful when members of the commissions have staggered terms of office and serve for longer periods. Management is less likely to be efficient if it is in the hands of the common council or if terms of office of members of non-partisan commissions and boards of public works expire at the same time. Experience and continuity of executive ability of the local water commission is necessary to conduct successfully a municipal water utility.

It has also been shown that almost without exception those responsible for the management of smaller municipally owned water utilities do not make provisions for expert advice to guide employees who are in direct charge of plant operation. In the few instances where management does employ outside expert advice, the professional service is of a non-continuous character. There is, of course, certain professional service that the state Commission should not attempt to furnish to such utilities. However, it must maintain a technical staff for effective rate and service regulation and it is highly desirable to provide municipal water utilities with preliminary technical assistance on many matters without usurping the field of outside professional engineers, accountants, and lawyers. It is interesting to note that in Wisconsin the use of the technical staff of the state Commission has led to a considerable increase in intelligent and efficient use of high-grade professional service employed independently by the municipal water utilities. This development has aided in increasing operating efficiency along lines suggested by the Commission.

Financing

Wisconsin has had in effect for many years certain statutes which provide for the issuance of utility plant mortgage bonds, sometimes referred to as revenue bonds because they are amortized from revenues. Municipal utilities are usually financed through the issuance and sale of such mortgage revenue bonds or by general obligation bonds of the municipality. The Commission has no jurisdiction over either type of bonds. Many thousands of dollars of mortgage revenue bonds, however, have been issued and sold; and in the majority of cases where bonds were issued, water plant managers have requested the Commission to investigate the feasibility of these projects and to assist in setting up the proper accounting procedure specified in the statutes. In recent years there has been an increased number of these projects to which the federal government has given financial aid. The findings of the Commission as to the feasibility of such projects have been relied upon by the municipal utilities concerned. Moreover the fact that there has been no default in the payment of any municipal utility bonds in Wisconsin (with one exception which was occasioned by management rather than by lack of funds) apparently has made the bonds attractive to investors.

The Commission has aided efficient water plant operations in supervising the disposition of revenues. This involves the relations between the water plant as a utility undertaking and the municipality as a governmental unit. In some cases the municipal officials seem to think that through the operation of a water utility it would be possible to obtain revenues to reduce taxes or to obtain necessary services, such as fire protection service, water used in public schools, public parks, and other municipal undertakings, without cost to the taxpayers or at reduced rates. In some communities the practice was to use a joint general fund and utility cash account with the result that utility funds could be diverted to municipal uses without detection. The outstanding example is the case of a municipal water utility's filing a sworn statement as to its financial status on December 31 in which it reported $207,000 of cash on hand. A check by a Commission accountant shortly thereafter disclosed that the water utility did not have a penny on hand because the entire amount had been used by the city without making proper entries in its accounts and records.

In these situations the Commission has strongly recommended and

sometimes required: first, that charges for fire protection service and public uses of water be made at regularly established nondiscriminatory rates; second, that utility funds and municipal funds be kept separate; and, third, that the disposition of utility revenues be recorded clearly and accurately. These policies have been adopted by the Commission not with the idea of depriving the municipality of surplus earnings to which it may be entitled but to insure that the water utility, as a proprietary undertaking, shall be operated on a businesslike basis.

Accounting

Some of the financial difficulties recounted above have been removed or minimized by the Commission's supervision over accounting and record keeping. In prescribing uniform systems of accounts for municipal water utilities, classified according to size, it was originally necessary to do considerable educational work. In some instances those in charge of the plants were apprehensive that proper methods of accounting might result in disclosures reflecting upon the capacity or integrity of the management. In a great many cases, particularly in the smaller communities, there was no one in the utility organization capable of keeping the records accurately. This latter situation seemed to prevail more frequently when plant managements changed with each change of municipal administration.

It is common practice, especially with the smaller plants, to have the city or village clerk keep the accounts for the utility, in addition to performing his duties as a municipal official. This office is usually elective and it is a well-known fact that such clerks are not often elected because of their accounting ability. This has necessitated closer scrutiny of the accounts of such utilities and a continual educational program sponsored by the Commission for the benefit of the changing personnel entrusted with the responsibility of keeping the utility's records. The close accounting supervision and assistance given to municipal utilities has resulted in recent years in many requests that Commission accountants make annual audits of such utilities. These audits in a few instances have disclosed defalcations and assisted the utility management in correcting the conditions which gave rise to them. The assistance to the managements in improving their accounting practices is given through correspondence, by review of annual reports of the utilities, and by field trips to go over accounting records and practices directly with the person doing

the job from day to day. It has resulted in improved accounting practices whereby the management obtains accurate and essential information necessary for businesslike operation.

Where the accounts and records were very poor, the Commission staff has prepared original cost valuations for the purpose of properly restating the accounts. In other instances the valuations prepared by the Commission staff in connection with acquisition cases have been helpful in properly stating or adjusting the water utility accounts.

Where municipally owned water utilities have been managed by a non-partisan board whose personnel was more or less permanent, the Commission has had little difficulty in securing hearty cooperation in placing in effect a uniform system of accounting. Such boards were quick to recognize the advantages of the system. Moreover the Commission accountants by studying the accounts of the various water utilities have become familiar with the operating details of each system to such an extent that often they have been able to suggest possible economies and improvements. Likewise the Commission's rates and research staff has prepared various statistical studies which have provided valuable information to plant managers.

The Commission has felt warranted in stressing uniform accounting and the keeping of proper operating records because accurate records of accounts are the first prerequisite of businesslike operation. Unless a plant manager knows where revenues come from and how funds are disbursed he cannot determine whether the plant is earning or losing money.

Legal Advice

Particularly in smaller communities, water plant managers are not familiar with the legal phases of their operations nor do they have ready access to attorneys familiar with such matters. Local attorneys are often unfamiliar with matters of utility law. Frequently, therefore, the Commission's legal staff is consulted for advice in handling legal problems that may arise. Because of the state-wide scope of the Commission's activities, its legal staff is able to bring to bear on a particular local problem the experience and information gained from dealing with similar problems in other communities over a long period of years.

The legal staff has been called upon to answer countless questions relating to financing, assessments, extensions, administration, meter-

ing, taxation, creation of municipal utility commissions, the personnel of utility commissions and their dealings with the utility, funds of municipal utilities, and procedure for the acquisition of existing utilities by a municipality and establishment of new water utilities in those municipalities where there is no existing utility. The Commission's legal staff has been asked to draft contracts, agreements, and ordinances, to advise municipalities and citizens with respect to the eligibility of the personnel of municipal utility commissions. It has analyzed and given advice on proposed extentions into unserved contiguous municipalities, answered numerous questions arising out of the relations of the municipal utility with the municipality as a political subdivision and its relations with its customers.

Many questions have also arisen relating to the use of utility funds by the municipality, and the department has been requested to advise whether a municipal utility could loan money to the municipality on the latter's promissory note. Wisconsin law defines the type of investment a municipal utility may make with utility funds as follows:

"Section 66.06 (11) (c) The income of a public utility owned by a municipality, shall first be used to meet operation, maintenance, depreciation, interest, and sinking fund requirements, local and school tax equivalents, additions and improvements, and other necessary disbursements or indebtedness. Income in excess of these requirements may be used to purchase and hold interest bearing bonds, issued for the acquisition of the utility, or bonds issued by the United States or any municipal corporation of this state, or insurance upon the life of an officer or manager of such utility, or may be paid into the general fund."

This has given rise to many questions both by municipalities and by the management of municipal utilities over the disposition of the net revenues received from the water department.

The legal department has drafted ordinances for the creation of utility commissions setting forth the terms of members, eligibility, organization, duties of officers, salaries, powers, and disposition of funds. Letters have been received from almost every municipal water utility in the state inquiring as to whether a mayor or councilman is eligible to serve on the board or commission managing the utility.

To summarize, it may be said that over a long period requests for legal advice have been received almost daily from city attorneys and other attorneys, water plant managements, municipal authorities, and in a few cases from customers.

The Commission has established minimum standards of service for the guidance of water utilities. These standards place the responsibility for the character and quality of service primarily upon the utility which is required to make periodic tests of the quality of its water, to keep a record of the results of all such tests, to test meters used to measure the water supplied to consumers, to flush dead-end mains and in other ways to secure an adequate supply of potable water.

Since the State Board of Health has concurrent jurisdiction as to the quality of water furnished, the Commission's rules provide that the quality of the water shall be such as to comply with the requirements of that board. Matters pertaining to public health are administered largely by the Board of Health while the Commission is concerned principally with providing adequate service at reasonable rates.

Many of the managers of municipal water plants were at first reluctant to make the necessary changes in order to improve the quality of their water supply, to insure the accuracy of meters, to provide sufficient pressure, etc. In part this reluctance may be attributed to a divided responsibility over service matters between the Commission, as a state agency, and the municipality. Since 1931, when the Public Utilities Law was revised, the Commission has had original and concurrent jurisdiction with municipalities over service matters including extensions of service. This revised statute removed the limitation on the Commission's power to act on its own motion to require improvements and extensions of service.

Service and Efficiency

The Commission has assisted the management of numerous small water utilities to work out specific main extension projects, sometimes where only general service was required and at other times where only fire protection was needed, or joint projects. Frequently water utilities have experienced difficulties and encountered public resentment through lack of uniform main extension rules and practices. In such cases the Commission has aided in the drafting of uniform extension rules which generally have had the effect of improving local public relations by elimination of discriminatory

practices. In fact, a set of water utility operating rules and regulations has been drafted by the Commission staff and is often used as a basis for the rules of individual utilities. In such work the Commission acts as a clearing house for information on the best practices.

The Commission's staff of service engineers is constantly making service inspections in the field. In the course of this work opportunities arise for suggesting changes in plant or in operating practices which will increase the efficiency of operations. As an illustration, the Commission has repeatedly urged water utilities to install station meters at pumping stations or to meter unmeasured service to customers and thus detect water losses and eliminate waste. One study by the rates and research department of the effect of a concentrated metering program in a number of communities shows an average reduction of 44 per cent in pumpage, or in costs variable with pumpage, as a result of metering formerly unmeasured service. Likewise in these communities the metering program afforded means of checking leaks on the system and unaccounted uses of water so that the percentage of lost water could be reduced.

Rates

Water plant managers in general are inclined to adopt rate schedules which are easy to administer but which neither provide a fair allocation of the costs of service among different classes of users nor avoid discrimination. Through the Commission's supervision over rates, water utilities have standardized rate schedules which are not regressive in character, which more fairly allocate the costs of supplying water to different classes of users, and which tend to promote more beneficial use of water. There is a notable lack of compiled rate information and the Commission's rates and research department has endeavored to remedy this by making various rate studies. As a result the water rate structure in Wisconsin is on the whole more uniform and more standardized than is the case in some other states. This uniformity not only aids municipal plant managers in avoiding complaints as to discrimination in their local communities but also aids consumers who may happen to move from one community to another and who do not as a result have to become acquainted with an entirely different type of rate schedule. The rates and research staff likewise has prepared tabulations of bills for water service in different communities which data have proved valuable to plant managers.

Complaints

Local prejudices and political influences have resulted in many sharp conflicts in the administration of water plants. The availability of the Commission for reviewing these controversies and settling complaints has tended to minimize their number and magnitude. Were it not for resort to the Commission, in some cases these local conflicts, whether between urban communities or between urban and suburban territories, might drag on interminably and result in waste of money, impaired service, and bad community spirit.

It is true that some people regard the Commission in its dealings with the managements of water utilities as a confirmed critic. They lose sight of the fact that these criticisms are intended to be constructive. Drastic treatment is resorted to only where circumstances call for such action. It has constantly been the aim of the Commission to keep its relations with water utility operators one of mutual assistance and satisfaction. Where criticism has been made it has been friendly and helpful in intent. After all, justifiable criticism is one of the implicit functions of a regulatory body in dealing with a monopolistic undertaking.

It has been with that friendly and helpful intent that the Wisconsin Public Service Commission has performed its work and has provided assistance to water utilities in organizing management, in financing, accounting, legal problems, matters of service and efficiency, establishing nondiscriminatory and adequate rates, and in settling general controversies and complaints which may arise regardless of the integrity and ability of those who are charged with operation and management of the utility.

The Engineer Looks at Management

By R. E. McDonnell

IN DISCUSSING management of water plants it must be asked whether or not the same type of management can be exercised and will prevail in both municipally owned and privately owned water works. In cases of municipal ownership the public is the beneficiary, and all of the results of good management accrue to the public. On the other hand, privately owned water works must be operated and managed in such manner as to assure profits to the stockholders.

The real purpose and objective of public ownership is the operation and management of the utility in such manner as to get the greatest good and benefit to the users, the owners. The basic purpose of private ownership is private profit, for it must be remembered that no private company plans to operate a water works without returning to the owners and stockholders a profit from the operation. We, therefore, must look quite definitely at management, comparing municipal operation and private operation. Both should aspire to good management. Each should strive to supply water of a good quality in sufficient quantities to meet all requirements, and do this at a reasonable cost.

It is expected that rates under private ownership be higher than rates under municipal ownership, because the objective of the municipal plant is to furnish good service at rates that will permit the water plant to pay only the operating expenses, interest on the borrowed capital, and to maintain the works in good condition. If there is a surplus over and above these requirements, the public is given the benefit of the savings in lower rates. The basic difference between the two is that one devotes its surplus to the reduction of rates

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in behalf of the community while the other devotes its surplus, in the form of dividends, to the owners and investors in its securities.

A recent survey shows that there are 12,760 water works installations in the United States, and of these, it is reported that 73 per cent are publicly owned.

In January, 1938, the author made an investigation of the ownership of all water works serving communities of 3,000 or more population. This investigation showed a total of 2,042 municipal and 827 private water works.

The statistics are given not with the view of pointing out any merits or demerits of municipal or private operation, but merely to show that comments on the management of water works must pertain to two classes—private and municipal. Neither side has any monopoly on the good or poor management.

If any deficiencies or shortcomings in the management and operation of a publicly-owned plant occur, every citizen, who is part owner of the property, readily voices his disapproval and objection. So the loudest outcry concerning poor management and efficiency is against the municipal plant. Stockholders of the private plants are usually silent in criticism of operation of the private plant. It is not an uncommon thing for a private plant to extol its virtues, good management, and operation, through paid advertisements in the press. It is a very uncommon thing for a municipal plant to give display advertising to its municipal management and operation.

The chief concern in management of water properties has been that of furnishing good, pure water. When one looks back to the "gay nineties" and recalls the enormous typhoid toll and illness from other water-borne diseases, and then compares conditions as they exist today, it must be conceded that there has been a long step forward in the treatment of water and the management of water purification plants.

Early treatment plants were directed largely at the removal of turbidity; then followed bacteria removal, color, odor, and taste removal, and the softening plants for removal of iron, manganese, and other impurities. Tastes and requirements have become so discriminating that water must now be almost perfect before it is passed upon and used as a water supply.

There are approximately 500 water softening plants in the United States, about 400 for the removal of iron, and nearly 1,200 that employ some means of odor and taste control.

All of these purification processes have resulted in almost complete elimination of typhoid in our larger cities. The *Journal of the American Medical Association* reported in May, 1939, that of the 93 cities of the United States having a population of 100,000 or more there were 29, or nearly a third, that did not have a single typhoid death in 1938; 48 cities had rates under two per 100,000; and but one city had as high a rate as six per 100,000. The remarkable decline in typhoid deaths was not entirely due to water purification but largely to the furnishing of better water to the communities. No phase of water works operation and management has undergone such remarkable changes and improvements as purification, and tribute should be paid to the many engineers, chemists, manufacturers, contractors, and water works superintendents who have contributed to the advances in the water purification processes; for, in the last analysis, the public passes judgment, in water works management and operation, more on the quality of water than on any other phase of the water works business.

The author does not intend to decry or belittle the standards of management and operation, but he would like, in this paper to point out some of the defects and shortcomings in the operation and management of water plants with a view to raising our standards. It is with this purpose that the remainder of the paper will be concerned.

Appraisals

It is surprising to observe how accurately some water works managers, superintendents, and engineers keep the costs of operation and at the same time guess at the value of their physical properties. Operating expenses cannot be intelligently determined without knowing the value of the property. A report on the value, age, condition, and efficiency of the various departments of the existing system should be made at least every ten years. One cannot intelligently show the depreciation allowance without having this inventory and appraisal.

Experience shows that private companies are better fortified with appraisals than the municipal plants; probably due somewhat to the fact that their appraisals are required frequently by utility commissions as a basis for adjustment of rates.

No merchant or manufacturer would think of doing business without frequent inventories and appraisals; and yet there are many water works officials who are merely fooling themselves in their operating

statements because they do not have knowledge of the value of their property. A good appraisal of the property is of equal importance and value to the operating manager as his pipe, pumps, valves, and hydrants. He will often buy new equipment and supplies but neglect entirely the slight expense of getting a good, accurate record of the value of his equipment. Market prices for materials and the cost of money vary greatly, and all items entering into the construction should be properly depreciated, otherwise a correct report on operation cannot be established.

To illustrate the relative reproduction value of water works properties from year to year: if 1913 values are taken as 100, the relative reproduction value of the same property in 1919 would be 250, by 1922 it would be 175, and in 1928 it would be 160. Reproduction value fluctuates from year to year. It shoud be accurately known by the manager or superintendent and used in determining the operating cost.

Utility Board Management

As a general rule the most satisfactory and economical operation of a municipally owned water property can be obtained through management by a utility board. This plan of operation has proved itself in any number of instances. The boards are generally elected or appointed for a term of office greater than that for other classes of city officials, thereby insuring a greater consistency and continuity of policy. With the longer term of office, the utility boards are freer of political control, and, for that reason, are more likely to attract to their membership the more capable business men of a community.

Utility boards generally include three to five members, and their terms of office are generally so rotated that not more than one member is relieved of his duties at any one time. This is accomplished by varying the term of office for the first members of the board. Often the personnel of the boards is left unchanged by continued re-appointment of those members who have demonstrated their willingness and ability to manage the affairs of the utility property. The continuity naturally contributes to a greater uniformity of policy, and permits well-thought-out, long-range improvement planning.

The utility board has additional advantages when applied to the management of two or more utilities. If the fullest measure of economy is to be realized, these two or more utilities must operate as

nearly as practicable as a unit—in some departments at least. They will want a common agency for supply purchases and a combined meter reading and billing department, and such provisions are possible with utility board management.

Water Rates

Many water works properties are being operated on rate schedules that need revision and adjustment. Too often water rate schedules are adopted hurriedly, without a careful study of operating costs, and frequently because some other city had a similar rate schedule. Many were adopted before the installation of water softening or water treatment plants, which have since increased the operating expenses.

A recent investigation of water rates in a small city showed that over 400 users were being furnished their water at less than cost, others, at an unduly high cost. Many water departments are operating with a minimum charge so low that it does not cover all of the items of expense that enter into every water account.

Nearly every water works plant in the country is serving water to suburban and outside communities. In reviewing the rate structures applied to these suburban consumers in over 100 cities wide variation was found—some being served at less than cost, others at double the cost to deliver, and many without any apparent regard to the increased cost of operation because of these outside services.

There is an astounding variation in rates charged for water throughout the country. For example, the average charge per 100 cubic feet of metered water in 11 of the largest cities in the United States varies from 5.1 cents in Chicago to 25.8 cents in San Francisco. Why Cleveland has a rate twice as high as Chicago, both using lake supply, is difficult to explain. Why Los Angeles should have a rate less than one-half the rate of San Francisco, where both cities use long-distance supplies, seems unusual. Why St. Louis should have a rate one-half that of Pittsburgh, both using river supplies with purification plants, is another difficult question. These great variations in rate structures exist in many cities. In some cases a difference would seem reasonable because of different methods of operation and financing. In many cases, however, rate schedules have been adopted without proper and adequate study. Local managers, superintendents, and operators dread to tackle any revision of water rates, feeling that such a step is loaded with the dynamite of criticism. The author was once called to the Pacific

Coast to make a study and investigation of water rates. It was explained that only a disinterested, outside engineer could withstand the criticism that would follow any rate revision.

The rate structures of water works plants are the most dangerous things to tamper with, and yet they are the one point of water works management and operation wherein there is the greatest need of improvement, standardization, and equalization. Rates should be in keeping with the operating expenses and fixed charges necessary to maintain the value of the property.

Political Management

No one can justify managing a water property as a political institution. Water works and politics do not mix. It is often said that there are two things you cannot take out of water. One is salt, and the other politics. Fortunately, very few cities in the country have utilized their water departments as a dumping ground for politicians. Wherever it has been attempted disastrous results have followed.

A comparison of the number of employees in the various water departments per 100,000 population usually reflects the degree of efficiency of management. A recent study of seventeen cities showed a remarkable range varying from 58 to 192.

While some per capita variation in the number of employees is to be expected due to the difference in treating and pumping requirements, a variation of over three to one does not appear to be justified. In this connection it is interesting to note that those water departments in cities which show the lowest number of employees are noted for the excellence of operation of their water utilities.

Cities, regardless of their size, have no business or excuse for permitting unsatisfactory operation of a utility that has such a tremendous influence upon the health and living conditions of the community.

Distribution Systems

Very few water works managers and operators have availed themselves of the new and improved means of studying hydraulic flow and pressure conditions which permit a more accurate design and layout of distribution mains and laterals.

Effective distribution of water in a municipality or a metropolitan area depends primarily upon the proper design of the system facili-

ties and upon the proper operation of these facilities. Recent progress in water works engineering has placed in the hands of the designer new devices and methods which undoubtedly will be largely used in the future for a more rational approach to the problem of delivering water to the consumer.

Ordinarily 50 to 70 per cent of the total cost of a water works property is represented by the distribution system. In spite of this fact the distribution system probably receives less study from the viewpoint of accurate design than any other part of the entire property. Reinforcing mains, laterals, and storage are often constructed without a definite knowledge of how they will function. Examples may readily be found of equalizing storage facilities improperly placed with respect to the center of demand, storage with such inadequate connecting mains that it fails to function when needed, and installation of new mains capable of relieving only existing conditions with no provisions made for future service.

That these faults exist is largely due to an imperfect understanding of just what happens in the distribution system during periods of critical demand. It is safe to say that to date no observations have ever been made that completely or even partly reflect the operating conditions throughout the system on the day of maximum demand. True, most systems are supplied with pressure gages, but these often are poorly located with reference to the trunk mains and reveal nothing as to the conditions of flow where they are located or in the trunk mains.

Modern instruments are available which can readily be adapted to the purpose of measuring flow throughout a system, the record of which can be made at the point of measurement or transmitted to a place of central observation. Such instruments installed at critical points on the trunk mains would provide a simultaneous record of flow throughout the system, and, when coordinated with the metered values of input to the system, would provide an invaluable means of determining usage, leakage, and deterioration of pipe lines. It is to be hoped that designers will install such apparatus, looking forward to the day when critical conditions of flow in the trunk main network may be definitely determined and studied. Certainly the investment in trunk mains warrants the small additional cost of such measuring devices.

Hypothetical problems involving future conditions of service can be based only in a general way on conditions existing at present.

Coefficients of friction in existing or proposed pipelines will change, population will shift, and the character of individual usage will vary.

A study of the city, based upon population for different areas and districts, should be made. The ultimate object of a study of population and use is to determine the amount and location of draft on the trunk main system. With this information available for critical periods of demand, such as the maximum hour, it is possible to set up a hydraulic analysis and determine the actual flow and pressure throughout the system for present demands or for future hypothetical conditions.

No method for analyzing the flow of water in a network of pipe such as the trunk mains of water works has ever been devised that is quite as satisfactory as the Hardy-Cross method. Practical experience in the use of this method has convinced the author that it represents the greatest advance yet made in this branch of water works engineering. Notwithstanding this fact, there are many water works superintendents and managers who merely extend mains to different districts without any scientific study or analysis as to the sizes of mains necessary or volume of water that may be required in these districts.

Although more than half the cost of the water works system is buried underground in the form of distribution facilities, that half of the value receives less study and more guess work than any other part of the system. On distribution systems, too, an intelligent study should be made of the volume of water to be delivered to the various outlying districts.

Uniform System of Accounting

Methods of billing and accounting have been the subject of much criticism in the water works profession. There is a great variety of practice in existence. Considerable criticism has arisen because private utilities are required to conform to an accounting system established by state utility commissions, and many municipalities have been free to adopt their own type, method, or system of accounting and billing. This criticism is, in a large measure, justified, for the accounting practices of many of the municipal plants are not what they should be.

Amortization practices, depreciation reserves, and surplus revenues are, as a rule, taken care of ably in the larger cities, but many of the smaller and medium size cities throughout the country have systems

of accounting, billing, and record-keeping that are obsolete and antiquated, and should by all means be revised and modernized.

Considerable criticism arises because of the charge that no taxes are being paid by the municipal plants, and that it is impossible to compare the rates of one community with another.

The best managed of the municipal plants are paying into the city treasury, in the form of taxes, contributions and free service, an amount in excess of the taxes of the privately owned utilities.

There is no justification whatever in managing a water plant and giving free service to a community without at least charging back the cost of the service rendered. It should be on a business basis wherein charges are made for all water furnished and delivered. If a surplus accumulates, rates should be reduced. There is no excuse for trying to run or finance a city out of the revenues of the city's utilities. A few cities have boasted of the fact that they are tax free, citing instances where the revenue from the publicly owned utilities is sufficient to run the city. This, in the opinion of the author, is not a sound procedure or practice and should not be followed in good water works management and operation. The savings in lower rates of these municipalities should be weighed against the taxes paid by the privately owned utilities to compare the community benefits locally and nationally.

Popularizing Water

Management of water plants has many times been on a strictly business basis, without sufficient consideration being given to the value of popularizing the product which is furnished to the community. Many engineers, superintendents, and managers have found from experience that it pays to tell the public all about the the product and the operation of the plant. This is found necessary and essential in every-day business, and is equally true of the public business. The fact was quite well recognized by the federal administration in allowing on P.W.A. projects an estimated 5 per cent to cover architecture and beautification of federal structures.

The owners of municipal plants are the citizens themselves. A large part of the cost is hidden and beneath the ground, and the conception of the project is gained, whether it be good or bad, by what is observed above ground in visiting the installation. There is nothing that conveys the idea of pure water more vividly than a visit to a purification plant kept spotlessly clean, pleasing in appearance, well

maintained, and beautified. The landscaping of water works structures is one of the things that a consulting engineer always has difficulty in carrying out. It is usually left until most of the funds have been exhausted for other purposes. Consequently, inadequate amounts are available. There are many notable examples of fine work accomplished in water works structures through beautifying the grounds and buildings. Some of the most notable are Springfield, Illinois; Little Rock, Arkansas; St. Louis, Missouri; and Los Angeles, California. These cities which have expended funds for such beautification and popularizing water have found it a paying proposition, and part of good management and service that should be rendered by every water department.

To a consulting engineer looking at water works management and operation, there is much encouragement in looking back over what has been accomplished over a long period of years of association with water works operators and managers. Very great improvement has been made, and progress is observable on every hand in making water works management better and better. There are still problems to be solved, however. If this paper appears unduly critical it was only with the hope that such critical analysis would assist in the solving of some of those problems. Forty-two years' association with the water works fraternity has convinced the author that only by a searching analysis of past failures can the groundwork be laid for the improvements which will be necessary tomorrow.

Management of Municipally Owned Water Works On a Business Basis

By Rollin F. MacDowell

DURING the past decade there has been a decided trend toward municipal ownership of public utilities, including water works as well as electric power plants. The reasons for the trend are not within the province of this paper, but they are probably centered around the control of rates and the service provided, along with the popularity and pride of municipal ownership.

But is it not true that there is now an accelerating tendency to discredit municipal ownership because of business policies of municipalities, especially with reference to the prevalent inability of those in charge of the administration of water works to fix or maintain water rates and service charges adequate to maintain and operate their plants on a business basis?

The purpose of this paper is to point out some of the elements of this situation and to raise a few questions in the hope that it will lead to a wholesome discussion of the problem, leaning toward legislation which will be to the interest of the public and the water works profession.

Public Water Supply Is Big Business

Water works has become "big business" in the United States. As recently pointed out by one writer, (1) "the 12,000 organizations in the field provide a wholesome and essential product to 80 million people in the United States." Its estimated annual income is about $450,000,000 and it employs over 60,000 persons. As a leading business, is not the water works industry entitled to management on a strictly business basis? By "business basis" is meant efficient

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operation and sufficient income to provide not only for proper maintenance, operation, and amortization of debts, but also a sinking fund for improvements as required. It also means a charge for all water consumed and the use of revenues for water works purposes only. It requires a charge against the general fund of the municipality for fire protection, but at the same time a credit to the general fund of an amount equivalent to the taxes which would be levied upon a private utility.

No private business is successful unless it operates as economically as possible, consistent with the greatest possible efficiency; pays its debts; sets up a reserve to meet emergencies and to provide for improvements and expansion; and, finally, charges enough for its goods to meet all costs and still leave a reasonable profit. And it would not long survive if it gave away a part of its product.

Elements of the Problem

The subject can be divided under the headings of "Legal Factors," "Free Water," "Fire Protection Service Charges," "Diversion of Revenues" and "Financial Policies." All of these, and other elements of the problem, vitally affect the ability of the water works superintendent to do a good job, to build up good will toward municipal ownership, and to serve best the public interest. They will be discussed here with special reference to the conditions in Ohio.

Legal Factors

Sections 3955 to 3963 inclusive, and 3982 of the General Code of Ohio give authority for the construction, acquisition, maintenance and operation of municipal utilities. Sections 3955 to 3963 inclusive give general powers to the municipal council; define the duties of the Service Director in cities and the Board of Public Affairs in villages; authorize the assessment and collection of water rentals, and limit the disposition thereof; and authorize the municipality to furnish free water for certain purposes. Section 3982 further covers the matter of free water for "municipal or public purposes" only, but on a permissive rather than a mandatory basis.

The courts have apparently never questioned the rights of cities and villages in Ohio, under these statutes, to build, operate and maintain municipal water works, and have definitely prohibited the diversion of the income from water rentals to other municipal departments. The statutes covering the furnishing of free water to public or chari-

table institutions, however, have been the cause of much litigation and of several opinions by the Attorney General's office. This problem will be discussed in more detail below. It is merely pointed out here that the statutes governing municipal water works have been the cause of much confusion in Ohio with respect to what may or may not be done legally. The lack of definitely worded laws, which are clearly constitutional, may be responsible, more than any other factor, for the inability of many municipal water works in Ohio to operate on a strictly business basis.

Another legal factor affecting the business management of municipal water works is the frequent inroad made by the courts and the State Legislature upon the laws previously placed on the statute books to protect water works revenues. As an example, we have recently experienced the practical nullification, by court action, of the lien provisions of Section 3958 G.C., which provides for the forced collection of water rentals by placing the amount due for same on the tax duplicate (2).

Another example is House Bill 741 which provides that 3 per cent of the gross revenues of a publicly-owned utility may be diverted for poor relief. This partially nullifies Section 3960 G.C. which prohibits diversion of water works funds to other municipal departments. Although adopted as a temporary or "stop-gap" measure, under stress of the relief situation, its possible re-enactment may be anticipated. Ohio water works men should be on their guard against unfavorable legislation at Columbus.

Another abuse, from a business standpoint, is the fact that the laws governing water works do not prevent the arbitrary setting of preferential rates, often below the cost of furnishing the water. And the State Utilities Commission has no control over the management of municipal utilities.

Free Water

Free water is an issue which rises periodically in one Ohio municipality after another. For many years it was regarded as mandatory that water be furnished free of charge for certain defined purposes, based on the wording of Section 3963 of the General Code of Ohio, which is as follows:

"No charge shall be made by a city or village, or by the water works department thereof, for supplying water for extinguishing fire,

cleaning fire apparatus, or for furnishing or supplying connections with fire hydrants, and keeping them in repair for fire department purposes, the cleaning of market houses, the use of any public building belonging to the corporation, or any hospital, asylum, or other charitable institution, devoted to the relief of the poor, aged, infirm, or destitute persons, or orphan or delinquent children, or for the use of the public school buildings in such city or village."

But 7 of 9 Courts of Appeals in Ohio have decided this statute to be unconstitutional and finally the Supreme Court also declared it so in the case of *Board of Education* v. *City of Columbus;* 118 O.S. 295, giving as its reasons, in part, that: (1) it is a violation of the rights conferred upon municipalities by Section 4 of Article XVIII, Ohio Constitution; (2) it results in taking private property without compensation therefor, in violation of Section 19, Article 1, Ohio Constitution; and (3) the legislature is without power to impose such restrictions or limitations upon municipalities.

Section 3982-1 G.C. further confuses the issue by providing as follows:

"The council of any municipality owning and operating municipal water, gas, or electric light plants, may provide by ordinance to furnish free of charge the products of such plants *when used for municipal or public purposes.*"

The constitutionality of this section of the General Code has not been passed on by the Supreme Court, though it is now apparently headed for the courts in the case of two ordinances recently passed by the Cleveland Council authorizing, respectively: (1) free water for public and parochial schools, charitable institutions, hospitals, libraries and cemeteries; and (2) free water for all municipal departments. These ordinances were passed in spite of a Cuyahoga County Common Pleas Court decision, in 1930, denying the city the right to furnish free water to either of the above classes of consumers. The Attorney General has interpreted Section 3982-1 G.C. as vesting a discretion in the council, but limiting the exercise of such discretion to use for *municipal* or *public* purposes. Many lawyers disagree with this opinion, and question the constitutionality of the statute. The confusion is in the interpretation of what is a "public use," even if the constitutionality of the statute were accepted.

Many municipalities have taken advantage of this situation to

furnish free water, or to make only a small charge, to a large number of public or semi-public institutions. That this practice is prevalent in cities throughout the country is shown by Table 1 compiled by the Department of Public Utilities of Cleveland as the result of a questionnaire sent to 100 Ohio cities and 40 cities of over 200,000 population in the United States. This table shows that the policy regarding

TABLE 1

Water Supplied to Institutions

Record of Policy Regarding Charges Made by Ohio Cities and Cities in United States with Populations Exceeding 200,000

	NO. OF CITIES REPORTING		NO CHARGE		PART CHARGE		FULL CHARGE	
	Ohio	U. S.	Ohio	U. S.	Ohio	U. S.	Ohio	U. S.
Public Schools	74	37	4	12	16	8	54	17
Parochial Schools	65	37	1	4	13	10	52	23
Other Sectarian Schools	42	37	2	3	6	9	34	23
Charitable Institutions	43	36	11	9	3	14	29	15
Hospitals	59	37	21	10	7	16	31	18
Libraries	69	36	20	15	6	4	43	20
Police Stations	73	37	58	25	3	4	12	8
Fire Stations	74	37	58	27	5	4	11	6
Bath Houses	39	36	22	21	2	5	15	14
City Markets	22	34	11	22	1	3	10	11
Parks	62	37	49	26	4	5	10	9
Playgrounds	59	36	42	23	4	4	13	11
Public Buildings	67	37	48	24	2	4	23	17
Cemeteries (private)	47	36	8	2	0	1	39	33
Cemeteries (public)	54	30	23	9	0	1	31	20

free water varies considerably in the different municipalities but that it follows the same general pattern and that the practice of furnishing free water to a large classification of institutions, as well as to all municipal departments, is quite prevalent in Ohio and throughout the country.

But does this make it good business practice? Three of the arguments against it, from a business standpoint, are:

1. It takes money from water consumers (in higher rates) and gives

it to the taxpayers and private individuals in violation of the due process laws of the state and federal governments. It is estimated that Cleveland's free water policy costs the average water consumer $1.80 per year in higher water bills.

2. It promotes the wastage and excess use of water by those receiving it free. This tends to increase water rates to the paying consumers.

3. It cannot be justified on the basis of charity as there is no more right for a municipality to furnish free water than to give away any other of its services, as electric power, building permits, etc. Privately-owned utilities do not give free service.

As an example to show that the furnishing of free water to public and charitable institutions means a sizeable loss of revenue to the

TABLE 2

Loss in Revenue through Free Water Service

CITY	(1930) POPULATION	AVE. YEARLY VALUE OF NON-PAYING ACCOUNTS		
		Amount	For Years	Amt. per Million Pop.
Cleveland....	*1,191,000	$425,000	1935 through 1939	$357,000
Columbus....	290,564	75,000	1920 through 1939	258,000
Akron.....	255,040	77,500	1928 through 1939	304,000

* Population Served.

water department, Table 2 gives the figures for several years in Cleveland, Columbus and Akron. The figures for Akron do not include a charge for fire hydrants which the water department makes to the city, on a bookkeeping basis, but does not collect, and which has averaged $50,200 per year for the past 12 years and $160,740 per year for the past 3 years. Otherwise, their record as to free water is very good and lists a relatively small number of free water accounts. Cleveland's figures do not include a fire hydrant charge, but do include a large number of public and charitable institutions which pay little or nothing for water service, including public schools, private and parochial schools, hospitals, asylums and rest homes, public buildings, cemeteries, parks and sewer flushing. And this is in spite of the Supreme Court decision that the law authorizing the furnishing of free water to other than municipal and public purposes is unconstitutional.

Fire Protection Service Charge

The fire-protection service charge is usually termed a "fire hydrant rental," which is really a misnomer, and misleading since fire hydrants are but a small part of the facilities in all water works systems which are provided solely or largely for fire protection. A fire hydrant rental, if charged, is merely a convenient method of fixing the charge for fire protection service and is rarely equal to the cost of such service.

From a business standpoint, every municipality should credit the water department, from its general fund, with an amount equivalent to that portion of the cost of maintenance and operation, as well as the amortization of the capital costs, of all of its facilities, from the source of water supply through the pumping station and distribution system to the fire hydrants, which are provided for fire protection. All of these facilities must be greater in capacity and usually much greater than necessary for purely domestic service, to provide the relatively high peak loads necessary at times of fire. This is especially true in the case of the storage facilities and the water mains.

A careful analysis of the total annual expenditures of any water works system, including amortization of construction, depreciation, etc. and including maintenance and operation, will show a surprisingly high percentage of this yearly cost attributable to fire protection. The Wisconsin Public Service Commission has made a detailed study of this problem, over a period of many years. They have concluded, as reported by Commissioner Nixon (3) that: "the best answer lies in developing a method of determining such charges in each community rather than the prescription of more or less standard rate schedules such as are applied to other classes of service. . . . The method can be described as a cost analysis, . . . broken down into steps described as follows: first, a separation of the used and useful property which can be said to have been built or installed for the purpose of being able to supply water at any time for fire protection service; second, a determination of the maximum demands which each major class of service makes on the utility; third, an estimate of the water used in fighting fires (usually a very small proportion of the total pumpage), plus a portion of the lost and unaccounted for water, since part of this is due to holding water in the system under pressure available for fire protection use; and fourth, a separation of the detailed operating expenses plus allow-

ances for fixed charges such as depreciation, taxes, and interest or return between the major classes of service."

The justification for a fire protection service charge is that such protection creates an expense which should be borne by the taxpayers as distinguished from the general consumers There are, of course, several exceptions to the principle and many mitigating conditions opposed to a full fire protection service charge against the general taxes, but the fact remains that, on a strictly business basis, municipal as well as privately-owned water works, and their consumers, are entitled to a reasonable return from the taxpayers for fire protection. As against this, the records show that relatively few municipalities make an inter-departmental charge for fire protection service, and even private utilities find it difficult to collect more than 10 per cent of their gross revenues for this class of service. The reason for this lies in the usual limitation in the general fund and the more persistent demands upon same by other departments. But does this excuse make the practice of ignoring the fire protection charge fair to the water works department?

On the other hand, should not the water works department be required, on an accounting basis, to pay to the general fund the equivalent of taxes that any private utility must. This practice is so rare as to seem almost heresy, but it is carried out in one of the largest cities in the United States, namely, Los Angeles.

Diversion of Revenues

Another violation of sound business practice is the recurring diversion of water works revenues to other municipal uses, always to the detriment of the proper management and the efficiency and improvement of the water works system. In the case of gasoline and automobile license taxes, which were originally provided for road and street maintenance and repair, and for traffic control, state legislatures have "gotten away with" the diversion of such funds against the strenuous protests of motorists and highway officials. And now we find that both legislatures and municipal councils find excuses to divert water works funds for other purposes, such as relief, as mentioned previously.

Section 3959 of the Ohio General Code provides that:

"After paying the expenses of conducting and managing the water works, any surplus therefrom may be applied to the repairs, enlargement or extension of the works or of the reservoirs, the payment of

the interest of any loan made for their construction or for the creation of a sinking fund for the liquidation of the debt. The amount authorized to be levied and assessed for water works purposes shall be applied by the Council to the creation of the sinking fund for the payment of the indebtedness incurred for the construction and extension of water works *and for no other purpose whatsoever.*"

This is certainly definite, but the law makers find loopholes in this law and divert water works revenues through free water and preferential rates, which results in higher water rates or inadequate funds for necessary improvements. Water works men should guard jealously the revenues of their departments and be prepared to fight against their diversion for other purposes than the present and future expenses of their departments, especially since such diversion is usually made in the face of frequent and incessant demands for lower water rates.

Financial Policy

The Ohio statutes require that rates be sufficient to operate and maintain the water works and pay debt charges, but do not prevent low preferential rates, below cost, to any consumer. A chamber of commerce sees an opportunity to secure a new industry. As an incentive it sells the municipal officials on the idea of furnishing them water at a very low rate. Does the municipality gain in the end? A candidate for mayor or council, seeking an issue which will bring him votes, finds a reserve in the water works fund which has been built up, by economy of operation, to meet necessary future improvements; so he campaigns with the promise of reduced water rates. A group of citizens representing public or parochial schools, or charitable institutions, "sand-bags" the council to pass legislation for the furnishing of free water to their public or semi-public buildings; and often wins. And so it goes, with no one fighting for the water department and proper revenues, and as a result, the water works plant is allowed to depreciate and its operating efficiency to be lowered until gradually the municipal ownership and the water department officials are discredited.

As an example of such a situation, the water department of one large city in Ohio ended the year 1939 with a balance of only $45,000 in its fund. Its improvements have always been financed by general obligation bonds only, so that, when the city has reached its general bond limit, no water works bonds can be issued, in spite of the fact

that the water works as a utility may have ample borrowing capacity. This policy certainly ignores the future needs of the water department. In spite of this, one of the issues in the recent mayoralty campaign in the city was that of lower water rates.

There is certainly no question, from a business standpoint, that water rates should be adequate, not only to meet the ordinary expenses of operation, and the debt charges on outstanding indebtedness, but to provide a reserve for depreciation and a sinking fund for necessary future improvements. But it is seldom, when a major capital expenditure is needed, as for a new source of supply or a filtration plant, that the money is available in the water works fund for the purpose. It is necessary to issue bonds, with the attendant expense and delays; and it is becoming increasingly difficult to secure authority to issue municipal bonds, even though the funds are vitally needed from the standpoint of economy of operation or of safety. In the last general election in Ohio a very small percentage of general obligation bond issues were voted favorably. The legislature is constantly making the issuance of bonds more difficult and the public, because of high taxes, is becoming "allergic" to bond issues. Even mortgage revenue bonds, which are usually the most logical and sound type for revenue producing municipal utilities, are frowned upon by councilmen because of their fear of public sentiment. Is not the answer to this situation the maintenance of adequate rates and the retention of the revenues from such rates to build up a sinking fund for future improvements?

Table 3, showing a comparison between the water works departments of Cleveland and Los Angeles, from a business policy basis, illustrates some of the principles referred to above. The figures speak for themselves, and show what can be done when a municipal water works is operated on a business basis.

Control of Rates and Revenues

What is the answer to the problem of controlling rates and revenues? Can the local officials, under the existing laws governing water works in Ohio, be depended upon to permit the water works to be operated on a business basis, to the interest of the general public? Or is it advisable to give authority to the State Utilities Commission, by law, to control the rates and general policies of municipal water works in the same manner as for privately-owned public utilities?

Nine of the states place such authority in the hands of their state

TABLE 3

Comparison Between Cleveland and Los Angeles as Regards Water Works Financing

	LOS ANGELES		CLEVELAND	
Yearly fire hydrant rental charge ($3.00 per month per hydrant)	$750,000		None	
Payment to general fund, (equivalent to taxes)	$730,000		None	
Free water furnished	None		All public, semi-public & charitable institutions	
Value of free water (5-yr. average)	None		$425,000	
Delinquent water accounts, 1939	$925,000		$4,553,000	
Water pumped which is charged for ..... %	93*		77.8 (1938)	
Ave. daily consumption *m.g.d.*	229		174.8	
Ave. revenue *per million cu. ft.*	$1.10		$1.04	
Per capita consumption *g.p.d.*	164†		87	
1939 operating revenues		$12,683,000		$5,036,000
1939 operating expense		$4,413,000‡		$2,425,000
Net operating balance		$8,270,000		$2,611,000
Non-operating revenue		$425,000		$97,000
Total balance before debt charges and depreciation		$8,695,000		$2,708,000
Other charges:				
Bond retirement	$3,140,000		$1,264,000	
Interest on outstanding bonds	2,334,000		1,019,000	
Depreciation charge	2,315,000	$7,789,000	278,000	$2,561,000
Balance before payment of taxes		$906,000		$147,000
Paid to general fund (equivalent of taxes)		$730,000		None
Net balance		$176,000		$147,000

* About one third of the supply is ground water, used for irrigation, all of which is collected for. A correction for this gives 90 per cent as total water charged for.

† Partially unmetered.

‡ Includes reserve for employees retirement and death benefit which, for 1939, was $400,000 in Los Angeles and $49,000 in Cleveland.

(*Table 3 Continued on Next Page*)

TABLE 3—*Concluded*

	LOS ANGELES	CLEVELAND
Value of system	$167,000,000	$60,210,000
Bonds outstanding	$67,000,000	$21,254,000
Area served within city limits, *sq. mi.*	350	78
Population served—total	1,485,000	1,300,000
Waste by leakage, estimated....%	7	13
Total water unsold....%	7	22.2

public utility commissions; namely, Colorado, Indiana, Maine, New Mexico, Rhode Island, South Dakota, West Virginia, Wisconsin and Wyoming. It is recognized that even state commissions are not always sacrosanct or without bias, but they are at least not so close to the situation as the municipal officials and are not as readily influenced by local individuals or groups. An outstanding example of state control which is decidedly in the interest of operation of municipal water works on a business basis is the Public Service Commission of Wisconsin. This Commission, under state law, carries on the following managerial activities in connection with municipal water utilities (4): (1) helps to establish more efficient management organizations; (2) gives aid in connection with financing of municipal utilities; (3) sets up standardized accounting regulations and gives auditing advice; (4) gives general legal advice to municipal officials pertaining to municipal utilities; (5) sets up standards of service and supervises same; (6) regulates rates; and (7) arbitrates local political and other controversies relative to water service and charges. As a result of its activities the Commission has eliminated many of the abuses outlined in this paper.

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An Engineer's View of Public Service After Four Years' Experience

By Frank O. Wallene

THE author, having completed four years of service as Director of the Department of Public Utilities of the City of Cleveland, intends, in this paper, to present some of the most interesting and instructive of the experiences he encountered in that service. Like most of you, the author is an engineer, trained in the manipulation of physical substances and forces. Human engineering as applied to managing employees was a simple and pleasant task, but, being immersed in politics with its illogical and to say the least uncertain processes was a different type of experience. Business-like administration, in the generally accepted sense, under such conditions is made most difficult if not impossible, and it is such differences as these that the author wishes to describe.

It was on January 1, 1936, as an appointee of Mayor Harold H. Burton of Cleveland, that the author took office. Being a member of the mayor's cabinet, the administrative branch of the municipal government, he had, in a measure, a responsibility in all city affairs, and, by the same token, the other members shared the responsibility for operation of the Department of Public Utilities. The fact that the utilities department was self-sustaining as distinguished from the rest which were tax supported caused more or less hostility and suspicion, and at times even malicious interference. The problems of the tax supported divisions, which are always hard pressed for funds, have become exceedingly complex, particularly in the large cities during this period of economic maladjustment.

The demands upon municipal government for service are increasing almost daily. Few people realize the extent to which municipal government is concerned with every individual from the time

A paper presented on April 22, 1940, at the Kansas City Convention by Frank O. Wallene, Former Director of Public Utilities, Cleveland, Ohio.

of registration of his birth until his death and burial certificate has been recorded. The public demands not only that its health but also that its general welfare be watched over. Such a task includes a large number of varied services, among which are included public utilities services, such as transportation, communication, light and power, gas, water and sewage disposal, all of which are regulated on the theory that people's rights, comforts and conveniences must be protected. Most of these utilities are privately owned with the exception of water and sewage. There are still quite a few privately owned water plants and even a few sewage systems. From this situation arises the much debated question of private ownership versus municipal ownership of utilities and the compromise of state government regulation which in theory may be one thing, but in effect something else because politics often displaces sound business reasoning.

Description of Cleveland's Utility Organizations

The Department of Public Utilities of Cleveland is divided into three divisions: water and heat, light and power, and sewage treatment and disposal (not including the sewer system proper). The total investment is approximately $110,000,000, the largest governmental department in the state of Ohio and larger in point of investment than any industry in the city of Cleveland. Its annual income is approximately $10,000,000. In its personnel of over 2,000 people are included representatives of practically every profession in the college curriculum, as well as clerks, tradesmen and common laborers. All are under civil service and to the same degree are as honest, capable and loyal a group as will be found in private business, particularly where comparable salaries are paid. In many instances the pay offered for positions of responsibility is shamefully low. This is somewhat true of all governmental service. Civil service regulations that in the past had been more or less ignored or wilfully disregarded in Cleveland have been lived up to these last four years. In some instances these regulations are too restrictive for efficient operation, but in the main they are a distinct benefit to the department.

Successive elections with their resultant changes had cost the self-sustaining Cleveland utilities department many millions of dollars. Prior to 1936, each election year showed a substantial increase in the number of people on its payroll, representing anywhere from $300,000 to $500,000 increase in payroll cost.

The oldest division, that of water and heat, dates back to 1856 and not only serves all of metropolitan Cleveland with water, but also provides central station steam heating in two sections of the city in the neighborhood of two of the pumping stations. The annual income of this division is approximately $5,500,000. Though in theory operating on a non-profit basis, it had a $25,000,000 bonded debt in 1936. This has been reduced to $20,000,000 in the four years since then. Such an enormous debt is inexcusable and indefensible and can only be charged to gross mismanagement. Over two million dollars a year are required for debt service. Bond money was used for ordinary main extensions because rates were set too low to provide sufficient revenue. In 1933, $4,000,000 in water works bonds, for which there was no immediate need, were sold at the highest interest rate in the department's history. Water was furnished to charitable institutions, churches and schools both public and private without legal authority. Delinquencies mounted to incredible heights during the depression, and efforts made to reduce the amount met with vigorous opposition. The principal argument was the possible ruin of corporations as well as individuals. Water bills were not to be mailed out just prior to an election. Politics had been the controlling factor in all policies concerning management.

The Division of Light and Power dates back to 1906. Its annual income is approximately $3,500,000. In 1914, under Mayor Newton D. Baker, the present generating station was constructed and placed in operation. It has an installed generating capacity of 50,000 kw. A new modern generating station is now being built adjacent to the present plant, and thereby hangs a tale which again illustrates the difficulties often encountered in governmentally owned utilities as distinguished from the privately owned.

In 1936 a study was made by the department engineers of the present plant with regard to its needs for modernization. In 1937, outside engineers were retained to make a separate and so-called impartial survey. Their report was to provide additional indication of the future policy and program that should be followed. Both reports showed a distinct need for modernization and the impracticability of modernizing the present station. It was suggested that a new station be constructed in the proximity of the present station, so that the two might be tied together mechanically as well as electrically to obtain higher efficiency. At that time the federal

government was not in a position to make a money grant, and as the city's inability to pay for street lighting service had for some time depleted the working capital to a point where no construction program could be attempted, the matter was dropped pending improved financial conditions.

Suddenly, in 1938, the Public Works Administration advised that it was ready to consider the city's application for a grant. At the time there was no money available for actual design engineering services. The study made by the outside engineers was a comprehensive and excellent report as such, but quite obviously included only a preliminary estimate of costs. These, however, were the only figures available for presentation to the P.W.A. on such short notice. On the assumption that the grant would be forthcoming, the engineers proceeded with the design at their own risk as regard to pay. Finally the money was obtained. As the ultimate design unfolded and the scheme of operation was completed, it became evident that the scope of the project must be changed in order properly to meet the conditions. In a private enterprise, not the preliminary figures, but an actual design estimate would have been worked out first, and from this would have been obtained final cost figures. But normal procedure, as known to the engineering profession, could not be followed, primarily because the time limit set by P.W.A. was a vital requirement of the agreement and was exceedingly short, and was made all the more so by lawsuits and a referendum election. When the need for more money than originally estimated became evident, the council held up its hands in pious horror. Something must be wrong. Some of them wanted to bring in the F.B.I. Over night they all became engineers. In the meantime, of course, the press was selling papers and the politicians were making votes. It was a practical demonstration of the difficulty of mixing engineering, which deals only in facts, and that kind of politics which thrives on confusion. It is hoped, however, that a year from now the city will have a new plant in spite of these elements.

The Sewage Disposal Division operates the three disposal plants which were completed in July, 1938. Prior to the time the author took office no definite plan had been adopted for raising revenue for their operation estimated to be from $1,000,000 to $1,200,000 per year, not including debt retirement. This fact was alarming and was recognized as a political "hot potato" of the first order. The

plan finally adopted was the so-called water volume method, which is generally considered the most equitable. After months of bickering the council finally passed a rate based on 40 per cent of the water bill with allowance for quantities not converted to sewage as shown on a separate water meter. Councilmen, having to be elected every two years and therefore always campaigning, complained that they were being continually criticized. Finally they rescinded the former ordinance, passing a new one that put the charge on the real estate tax duplicate. The suburban communities are also served by these plants and in their case the problem of contractual relationship is even more difficult since they also have their own political situations to meet. It was impossible to shut them off, because in so doing some of the city's own sewers would have been backed up. As yet no conclusion has been reached. Here again is an illustration of the lack of business-like approach to community problems by public officials.

Certain Laws Handicap Administration

Laws are a necessary requirement, but the laws that established the system under which the Department of Public Utilities now operates were, beyond a doubt, drawn up by those who had only a limited knowledge of utility functions and requirements due to the necessity for continuity of service. For instance, the department found it necessary to keep an unnecessarily large quantity of supplies on hand, valued at close to a million dollars, because it requires anywhere from five to twelve months to obtain material, from the time the need is cited until delivery is made.

Purchasing for such a large utility is obviously an extremely important function, and under the prevailing "Horse and Buggy Day" laws, a most difficult one. It requires not only honest management, but specially trained personnel to avoid purchase of inferior goods that may be cheaper initially but actually costlier, and dangerous to plant operation. This has become particularly true since the depression, which gave rise to increasingly keener competition. The usual phrase in municipal law reads that the award shall be made to "the lowest and best responsible bidder." Cleveland's charter excluded the words "and best," thus in effect excluding recognition of quality of material or design. To avoid becoming the proving grounds for untried or questionable equipment and materials, specifications must be carefully written. It is, no doubt, obvious

that it is almost impossible to anticipate all trick devices of the so-called unscrupulous vendor. Thus the specification writer becomes the target for abuse not only by the disappointed vendor, but by the ever-present official who has little knowledge of the matter, but who thinks he knows best and often by his actions indicates that he cares little about the department's welfare.

The public relations problem of the department, and particularly in a large city such as Cleveland, is extremely difficult, especially where thirty-three councilmen, elected every two years by wards, are constantly confronted with the problem of seeking re-election by trying to please their constituents. Politics must of course enter into the picture. Webster says that "politics is the science and art of government." That sounds fine, but there is more than one kind of politics. Many of the so-called professional politicans show a a desire to go along with what is best for the community, but altogether too often the community welfare becomes secondary in importance. That, of course, is America. How we love it! We would not give it up for anything in the world. Yet, there is a serious absence of that compelling force that is behind the aristocratic or monarchial type of government, and that is the lack of continuity of policy. For that reason cities must be managed not only with honesty of purpose, but with a caution not to destroy worthwhile progress already made by the introduction of policies that eventually may be harmful to the community.

In summarizing, it must be admitted that any man's opinion of public service will depend to a great extent on his own experience, his inherent ideals and training, as well as his ultimate purpose. Thus the career man tempers his determinations or policies and often vacillates in order to keep in the good graces of the so-called bosses. Naturally, such a policy is dictated as a matter of self-preservation. Not so with the man who is appointed or elected for a specific term. His is not a career. He realizes at the outset that in spite of his accomplishments he is traveling down a dead-end street. He is usually looked to for initiative, if not leadership; he is often criticized, justly or otherwise, as he attempts progress. Men are born with five senses, but to be equipped for public service, and more particularly in an executive capacity, he actually needs three more: a sense of humor, sense of fairness and common sense.

Sense of humor makes it possible for him to laugh at the cheap criticism or smooth trickery of the ever-present pseudo-intellectual

giants and their cohorts. Sense of fairness enables him to determine the average value of a plan or policy as well as the algebraic sums of the faults and virtues of his fellow-man. Common sense is a combination of both humor and fairness that gives the stop and go signal in formulating policies. Without these added senses, even the honest hard-working official, who earnestly goes about his duties with diligence and seldom hears from business men, but because of his position must still listen to the cocksure politicians, will find himself in difficulty. One could wish to be as sure about one thing as the American politician is about everything. It would seem that business and professional men have been indifferent so long about governmental affairs that the politicians have come to regard government as existing for their special benefit.

In the author's opinion public life is worthy of any engineer's skill, but he must understand at the outset that the management of publicly-owned utilities, particularly in the large city, requires knowledge of subtle forces not referred to in engineering or accounting handbooks. An engineer's viewpoint is needed in governmental affairs, and he should have the courage to stay with it in spite of the many distasteful difficulties. The form of city government has everything to do with the degree of efficiency attainable. It is the author's feeling that the city managership plan with a small council elected at large is best. In any event, water and sewage disposal which are distinctly health measures and therefore vitally important, and usually self-sustaining, should be entirely separated from municipal government, with its recurring elections and temptations for political sabotage. This, as many of you know, is the set-up in many communities, and there is plenty of evidence of its advantages.

Finally a word of suggestion to those of you who are career men. When you discover that you have an executive who is sincere and wants to do a good job, offer him your aid in analyzing and evaluating the effects of political procedures. Remind him that favorable public opinion is important but often illusive and difficult to control particularly when newspapers are being nettled by selfish interests.

Team work is more necessary today than ever before. It requires an approach to our problems with a spirit of cooperation, comprehension and loyal support in order to obtain the full measure of our objectives.

The Kind of Boss I Like

By Lorenzo Semple, Jr.

SHORTLY after the World War I was living in a small community off the north coast of Africa. There were about three hundred and fifty souls in the community, ranging from the big boss himself to the most menial type of worker. We three hundred and fifty souls all lived within the confines of a space five hundred and fifty-five feet long and fifty-five feet wide; it was the U. S. Cruiser "Detroit," and I was an officer aboard her. This was long before I had anything to do with the operation of a water works.

In the Navy, there are two kinds of ships—a "happy ship" and a "madhouse." We were considered a "happy ship." We had an efficiency "E" which we wore proudly on the stacks as an award for exceeding our engineering bogey. We also wore a gunnery efficiency "E" on one of the turrets. Our ship was one which in terms of industry made money. When we were returning home for Christmas we fell in for the first time with a new cruiser which was to relieve us on our station. This new cruiser was a sister-ship; she had similar equipment and living quarters, and a similar complement of officers and crew. But while she was similar in these respects she was not the same, for she was a self-styled "madhouse." I am convinced that the one distinguishing feature between those ships was the difference in morale of those two groups of men.

While I do not attempt to draw any exact similes between the naval and military services and the organization, along more democratic lines, of the companies and firms we all work for, there is one thing they do have in common—morale.

What is this thing we call morale? Where does it come from and how is it engendered? The dictionary defines it sparingly thus:

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"morale: as applied to a military establishment, courage and confidence," and this does not help very much. I do not think that is a very complete definition as applied to us so I shall attempt a definition myself. It seems to me that morale has three component parts: your attitude toward yourself, self-respect; your attitude toward your job, enthusiasm; and your attitude toward your fellow workers, cooperation.

Perhaps the most obscure phase of psychology is the average human being's attitude towards himself. Suffice it to say that it should include self-respect without petty vanity, confidence in ability without boastfulness, and the tenacity and courage to perform whatever task is assigned to the best of one's ability.

The second element in morale is one's attitude toward one's job. I do not think that it is necessarily high when jobs are easy, or that it is low when jobs are difficult. On the contrary, it is usually most apparent when there is much work to do, for it is difficult to keep tuned up when things are slack. When work is properly distributed among those available, and when there is a general feeling throughout the organization that there is being afforded proper instruction and a reasonable opportunity to learn to do the job well, then there will be enthusiasm and the morale of that organization will be high. Respect for yourself, enthusiasm for your job, and belief in its value are the foundations of good morale.

The third element in morale—your attitude toward your fellow workers, cooperation—will be high when you have respect and confidence in them to perform their shares of the tasks well too; when you know that if you bend your back to the oar you will not be pulling along with you some dead weight. In the lumber camps, when two men are operating a cross-cut saw, that workman who is doing most of the work sarcastically requests his fellow workman, if he will not help saw, at least not to drag his feet. These are the requirements of high morale, self-respect, enthusiasm, cooperation. If the greatest of these is not self-respect, it is at least true that no man's success is secure except it be founded upon self-respect.

So you see, morale is not something that can be escaped from; it is always present and it may be high morale or low morale, but there is never an absence of it; therefore it is a fact and we must face it. But where does it come from? Where does it start? I am convinced that high morale enters an organization at the top through the big boss and works on down through all those layers of lesser bosses.

For we must remember that all human activities are organized into various levels, each one with a different degree of responsibility, each one with a different amount of knowledge and skill to perform its task, and all along the line are bosses—someone is always bossing someone else. It is necessary and it should be that way.

Now, since we are talking about bosses, let me assure you that I shall not have the temerity to tell any boss what kind of boss he should be. But I am going to give you my own opinion of what kind of boss I like to work for. If you do not agree with me, it means only that we have different tastes, for you are as entitled to your opinion as am I to mine. Furthermore, I am not thinking of the kind of boss I would like to have for any one particular job, because what I shall say holds good whether my boss be the outside foreman, the cashier, the manager, the president or the board of directors. And I am judging my boss particularly in light of the atmosphere of change and uncertainty and new problems and trials under which civilization now exists.

In the first place, I want my boss to keep his feet on the ground, to think things through clearly and not be swayed by every wind that blows. In times such as these, the "dope straight from the feed bag" contaminates the air. I want to believe that my boss is actuated by reason rather than half-baked suspicion, and that he takes the trouble to keep himself well posted on the "whys and wherefores" of things about us.

I want my boss to explain to me what he and others in the company think about things; what the general problems and policies of the company are, what he and they propose *I* should do about them, and how he suggests I might try to do it.

I expect my boss to be fairly well posted on such things as rising wages and salaries in other more volatile industries, so that if I listen to the siren's call he can really give me the low down on what the chances are that the boom will last and advise me reasonably and sincerely.

It seems to me that the boss that I would like to work for does not have to be easy-going and careless. For, if he is easy-going and and careless and is not terribly particular about how he does his job himself, or how I do mine, it always slacks me up, for we are all prone to follow a bad example. If I do not do my own job well, I know that I won't be happy. The kind of boss I would like to have is one who exerts a proper amount of discipline and is not afraid to

work himself. By using proper and fair discipline he takes a load off my shoulders; the boss can help me do my job well in really being my boss.

I don't want my boss to be paternalistic and inquisitive about my personal affairs. Just because I am on his payroll and work for him and am a member of his company, I do not think it gives him any right to say who my friends should be or how I should live. I do realize, however, that so long as I am a member of his organization, I must represent his organization properly. Therefore, if my private actions outside of office hours threaten the reputation or position of my company, I do not call his concern over me paternalistic; I call that proper inquisitiveness on his part. I think that rather than being paternal, I would like to have my boss solicitous over me, solicitous over all the little trials and tribulations I encounter, for when I do have them I don't want to think—"Well, that is none of his business, I should handle my own troubles." While he is up there, above, making more money that I am, he is paid for taking a little additional responsibility. I want to know I have someone to go to when I get in trouble, and I would like my boss to give me a kind word and helpful suggestions.

I do not want my boss to be capricious or erratic. The Constitution of the United States, as we all know, protects us against cruel and unusual punishment. I do not think that my welfare should depend on which side of the bed he got out of in the morning. I do not like to work for a boss like that. I like my boss to be even-tempered, to carry on and not wear his own difficulties on his cuff. They may be gigantic to him but are not my affair and not of my doing. I like to have him even-tempered, steady and reliable. I want to know where I stand all the time.

I don't want my boss to surround me with nepotism and favoritism. When I say nepotism I refer to Gilbert and Sullivan's "Admiral," who, when he went to sea, was surrounded by "his sisters and his cousins, which he reckons by the dozens, and his aunts." I do not think that is a situation in which I can be happy and do my best work. After all, I should be entitled to know that merit, and merit alone, will be justly rewarded.

I do not like to have my boss put the blame on me for things which are not my fault. On the other hand, I know I am going to make mistakes and when I do I want my boss to give me constructive criticism and correction. Another thing, even when I am wrong

I want my boss to back me up publicly; he can take me aside but I don't want him to reprimand me in front of the hired help or in front of the public. I want him to back me up. If he has confidence in me he should do that or else he should fire me.

I do not want the bigger bosses to be blind and unnoticing and walk nonchalantly through the establishment. They ought to know my name and use it. Perhaps all of you have heard about the man who went home and told his wife: "The boss spoke to me today; he said 'Get the hell out of my way.' "

I do not like to have my boss secretive about the affairs of the company; he should accompany his instructions with a better explanation than "because I tell you to do it." It seems to me that the boss ought to take me into his confidence and tell me the "whys and wherefores" of the things he wants me to do. He will get better results when I understand what he has in mind, for then I can do it for him better. Perhaps he has not had the time or opportunity to think out clearly for himself the details of carrying out the task, and perhaps if he takes me into his confidence and tells me what his objective is, I will be able to be of real assistance to him in solving the problem.

I think there is no question at all that none of us likes to work for a "sourpuss." I think I am entitled, when I am with my boss, to find him cheerful, bright and pleasant to me.

If my boss thinks more about how I may like to be treated and is guided accordingly, I am likely to be a lot more willing and anxious to understand what he wants me to do and to do my best to accomplish it. He and I will both be happier during times when there is plenty of trouble and worry around.

Speaking of trouble, I would like to touch for a moment on our experience at South Pittsburgh during the 1936 flood. Most of you are familiar with what happened, how our Beck's Run station continued to be operated with the water level outside the plant well above the fire boxes and how only when it commenced caving in windows were the fires drawn, the operators escaping through the roof. You know how water was delivered in cans by truck to all customers in the high districts out of service; how the station was once again started up before the water was off the floor. Who did all this? Everyone. Ranks and grades were forgotten. Clerks from the office force rode water trucks; engineers left their desks and drafting boards to wade waist deep in water, clearing away debris;

the president of the company, in addition to directing the work, helped the superintendent's wife prepare food for the men on the spot; the specialists from the home office, who had arrived by chartered plane, worked shoulder to shoulder with laborers at the common task. Here was an example of self-sacrifice and enthusiasm for public service resulting from the high morale of that organization. And we have concrete evidence that the spirit of that organization, its competence and enthusiasm in meeting the emergency so impressed the public served that a new feeling of confidence and understanding toward the company arose in the minds of its customers.

But this is a reputation the whole industry enjoys—its ability and willingness to meet physical emergencies in the public interest. Indeed it is no more than what we conceive to be our duty. But I know a little water company that never had a flood or a hurricane or any other kind of spectacular emergency. Nothing much out of the ordinary ever seemed to happen in that small mid-western town. The manager was liked and respected both by the public and by his little family of employees, and calmly and faithfully they carried on the daily tasks. One day an investment banker from the big city persuaded the mayor that the town should own its own plant; in fact he very generously undertook to finance the proposition. A referendum was called. The company took no part in the campaign, but when the votes were counted it was seen that the company had been invited by a large majority to remain in that town and continue doing business as usual. The people said that the company had always treated them fairly and from what they could see and hear, it had also always treated its own employees, who were also their fellow townsmen, fairly. The company, they said, had a certain atmosphere about it which they liked.

Now, since you, to whom I am speaking, are the big bosses in the companies you represent, it is upon you that the responsibility for creating high morale in your organizations, and keeping it so, rests. But since morale trickles downward from level to level through the actions of other bosses, you can only properly acquit youselves of this responsibility when you have made it your practice to have continuous first hand knowledge of how all the lesser bosses are bossing. In this way only can you have a "happy ship" and one in which the spirit of every member will constantly impress upon the public that your company is prepared to meet successfully whatever the fates may hold in store for it.

As You Like It—In Public Relations

By John C. Mellett

IT IS always refreshing to find a few minutes of a program allotted to the subject of public relations, but it is somewhat discouraging to find so-called public relations men assigned to lead the discussion. After several years of experience the author has concluded that a great many silly things are done in the utility business, and one of the silliest is to regard public relations as a separate subject, a detached phase of the utility business, a specialized field of activity, warranting either the employment of an expert or, at least, "some *thought* every Tuesday at two o'clock."

The truth, of course, is that every employee in the business must be a public relations man. It might very well be more worth while to have a good meter reader discussing this subject than to have a mere public relations man doing it, because the meter reader probably knows and contacts ten times as many customers as any public relations man can!

In this paper will be reviewed briefly a few of the things the author has learned in the last twenty years. Do not be alarmed, for it is *not* written to advocate "good public relations"! That has been done, over and over and over; and it is always reminiscent of the candidate who favors the home, exalts the family, and honors womanhood, at the same time as he calls for 100 per cent Americanism!

Urging good public relations in this day and age is just as much a waste of time as urging people to breathe, or eat! We *have* to do those things; and we don't need a breathing man, or an eating department, to attend to them for us. We all handle our share of

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these jobs, for our own selfish reasons, and, essentially, they, too are the reasons why we all have to be public relations men in the public utility business.

The reasons are identical, whether we are in the municipal or the private field, for the business must be transacted, and we hope to be the ones employed to handle it. And, usually, we start from exactly the same point, which is the free-born American citizen's natural right to resent the fact that he can not shop around, dicker or haggle over his utility service. If he wants water service he has either to provide it for himself or buy it from us on the same terms that everybody else buys it. There is not much freedom of action for him, in that course. He gets fussy, sometimes hot under the collar, and either votes us out of jobs or starts a rate case or other procedure before the public service commission.

In the last twenty years, utilities have recognized the customer's feelings, and either ignored them or done something about them. Let us ignore those utilities which ignore the customer's sensibilities, as being beyond all hope, and examine those which have done something in the situation. This brings us to the sole objective of this discussion.

If Shakespeare were in this business and wrote *As You Like It* out of his experiences, he could make it a tragedy. Some of us have tried to do that, in public relations. We used the title, however, which read like this: *You Like What We Do.*

We did as we liked, and then, remembering the customers, we employed a public relations man, used advertising, lawyers, mayors, accountants, rate experts, etc., to make them like it. Sometimes they liked it; more often, they merely tolerated it. Whatever the fact, we were accessories *after* it. There was no happy ending; the tragedy merely dragged on, and on.

Some of us have tried to make a comedy of public relations, using the title: *We Do As You Like.*

We cast all our characters—meter readers, accountants, cashiers, service men, the big strong fellows who shovel chlorine into the water—and all of them we tried to cast as public relations men. We tried to require good manners, courtesy and patience of our actors. We sought to arrange our rates so that customers could use more service and find it economical. We told customers how to avoid freeze-ups, instead of waiting to fuss with them about the cost

of repairs. In short, desiring good public relations, we tried to be accessories *before* the fact. Whether we will have a happy ending or not, our comedy has been more pleasant for our actors and our customers—better filled with better spirit—than the tragedy.

But those of us who have tried to make the customers like what we do, as well as those of us who have tried to do what the customers might like—both groups of us—are well ahead of the other fellows, who chose to ignore the customers' feelings altogether, for many of them are out of jobs, or out of business now.

Personally, the author prefers a program of trying to do what the customers will like and appreciate. It means more real public relations work, but we can divide it up among *all* the employees who contact customers in any way whatsoever (for chemists and ditch-diggers alike are honestly public relations men in the utility business) to spread the task. It does mean more work, but we asked for it, and we want to keep it.

As You Like It should be our name for public relations.

Water Rate Structures in American Cities

By E. W. Moke

IN THIS study a survey has been made of the types of water rates and charges for general metered service and public and private fire protection service covering a representative sample of cities in the United States serving 10,000 population or more. An analysis has also been made of the relative level of some of the charges for service. For general service, such an analysis was prepared on graduated minimum bills and service charges. For public and private fire protection service, analysis of specific charges was limited to the most prevalent types of rates.

The study is based on abstracts of water department and company rates published by *The American City.** In several cases, where definite information was available indicating rate changes made since the date of abstract, the source data were revised.

According to the 1930 census there were 911 cities in the United States with population of 10,000 or more. Three hundred and ninety-three are considered in this study. One of these, however, has been excluded in most computations because of combination with sewer service. Although this represents an overall sample of 43.1 per cent, the sample is about 30 per cent of cities of 10,000 to 20,000 population, 47 per cent of cities of 20,000 to 50,000 population, and progressively higher percentages for larger cities. The cities studied were grouped into six population groups. The proportionate sample of total United States cities included in each group, and its range of population, are shown by Table 1.

The population served, rather than the 1930 census, was used as the basis of classifying cities. As a result there are included some

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* *American City*, 1934, 1935 and March to September, 1939; and *Municipal Index*, 1934.

cities which, according to the census, have a population of less than 10,000. It was believed that, in general, the extent of population served would have a more significant effect on the type or level of rates than the population included within the city limits. The characteristics of corporate limits will vary among communities and it may be found that some public water systems serve a substantial urban or congested area beyond the corporate limits whereas, with others, the corporate limits may include considerable thinly saturated area not receiving water service from a public distribution system. In some communities a portion of the population may also have readily available a substitute source of supply such as private wells.

TABLE 1

Proportion of United States Cities Included in Study

POPULATION RANGE	NUMBER OF CITIES IN U. S. A.*	CITIES INCLUDED IN ANALYSIS	
		Number	Per Cent of Total in U. S. A.
500,000 and over	13	11	84.6
200,000–499,999	28	21	75.0
100,000–199,999	52	38	73.1
50,000– 99,999	98	58	59.2
20,000– 49,999	267	126	47.2
10,000– 19,999	453	135	29.8
Total	911	389†	

* 1930 census.

† The total of 393 cities in the study includes several cities with population less than 10,000, but the population served by the water works system is 10,000 or more.

Classifying the cities on the basis of population served resulted in a relatively small number of shifts from one group to another, as compared with a classification on the basis of census population.

Characteristics of Rate Schedules for General Service (Metered)

A frequency distribution of rate schedules as to type and characteristics is shown in Table 2. This refers to the rates applied for service to general users, primarily residential, commercial and industrial. In general, it is practically a universal practice for water departments and companies to charge for metered general service on a single rate schedule. In some cases, separate schedules or rate

provisions have been established for specific purposes or classes of customers, such as industrial, manufacturing, public, municipal, county, charitable institutions, churches, schools, colleges, irrigation

TABLE 2

Characteristics of Water Rate Schedules for Metered General Service United States Cities Serving 10,000 Population or More

	POPULATION GROUPS						
	500,000 and over	200,000 499,999	100,000 199,999	50,000 99,999	20,000 49,999	10,000 19,999	Total
A. Types as to Minimum Bill or Service Charge							
Single Minimum Bill	2	7	14	21	57	74	175
Graduated Minimum Bill	4	6	11	23	39	36	119
Total	6	13	25	44	96	110	294
Single Service Charge	1			1	1	1	4
Graduated Service Charge	1	3	7	5	14	11	41
Total	2	3	7	6	15	12	45
Single Min.—Single Serv. Chg.				1	1	2	4
Single Min.—Graduated Serv. Chg.	1		2	6	3	2	14
Graduated Min.—Single Serv. Chg.						1	1
Graduated Min.—Graduated Serv. Chg.	1	3	2	3		3	12
Total	2	3	4	10	4	8	31
No Min. or Serv. Chg.				1	1	4	6
Total All Types	10	19	36	61	116	134	376*

* Omits 16 on which no information was available regarding provisions for minimum bill or service charge, and one which combined sewer and water service in the same schedule of rates.

(*Table 2 is continued on next page.*)

or sprinkling. Less than 10 per cent of the cities studied provided special rates for industrial or manufacturing service. Many of these rates are limited in their availability and, in most cases, the rates

TABLE 2—*Concluded*

	POPULATION GROUPS						
	500,000 and over	200,000 499,999	100,000 199,999	50,000 99,999	20,000 49,999	10,000 19,999	Total
B. As to Graduated Min. Bill or Service Charge							
Graduated†	7	12	22	37	56	53	187
Not Graduated	3	7	14	23	59	77	183
Total	10	19	36	60	115	130	370‡
C. Blocking—No. of Blocks§							
1	3	1	3	4	10	5	26
2		5	3	8	4	9	29
3	4	1	8	6	22	27	68
4	3	4	5	9	11	19	51
5		2	7	10	17	18	54
6		1	2	7	19	18	47
7	1		3	4	6	11	25
8		3	1	4	8	3	19
9			1	3	3	5	12
10				1	8	3	12
Over 10	1	4		3		9	17
Total	12	21	33	59	108	127	360¶
D. Manner of Billing							
Monthly	3	8	14	32	43	73	173
Quarterly	5	7	15	22	48	40	137
Semi-Annually	2		2	4	4	5	17
Annually		1		2	1	4	8
Combination	1	3	3	3	20	10	40
Miscellaneous		1				2	3
Total	11	20	34	63	116	134	378¶

† Either the minimum bill or service charge graduated with the size of meter or service, i.e., increasing with the size.

‡ Includes only those schedules providing for either a minimum charge or service charge.

§ Cities having a wholly regressive type of rate (step rate) have been excluded from this summary. These total 30 out of the 393 under study; 3 in 3rd population group, 6 in 4th, 9 in 5th, and 12 in 6th. No information was available on blocking of two schedules and one was excluded because of combination with sewer service. Seven schedules were included in the 360 which represent a combined block rate and step rate; 1 in 4th population group, 3 in 5th and 3 in 6th.

¶ Number of rate schedules on which data were available.

were of a type similar to that for general service so that a classification as to type could easily be made.

Table 2 shows a frequency distribution as to the types of rate schedules classified by population groups, and covers the following characteristics: (1) rate schedules with minimum bill or service charge provisions; (2) the extent to which minimum bills or service charges are graduated with the size of meter or service; (3) the number of blocks used in quoting the schedule of output charges; and (4) frequency of billing.

Minimum Bill or Service Charge Provisions

Rate schedules by which the customer receives an allowance of water for the payment of a minimum charge were considered as "Minimum Bill" type of rates. Schedules under which no water was supplied for the payment of initial specified charges were considered as "Service Charge" type of rates.

Several variations of the "Minimum Bill" type of rate are applied. The quantity of water which the customer receives for the payment of a minimum charge may be quoted as a specified quantity or may be that resulting from the application of the regular schedule of block rates and output charges. The minimum bill may be stated as a uniform amount irrespective of the size of connection or meter, or it may be graduated, increasing as the size of meter or service increases. If graduated, the schedule may be combined with either of the two types of "quantity of water" provisions previously mentioned. Out of 132 rate schedules, which contained graduated minimum bill provisions, 16, or about 12 per cent were of a type which stipulated a specific and uniform allowance of water as included in the varying minimum charges. Occasionally a rate schedule will stipulate specific varying amounts of water with each one of the graduated minimum charges, and the balance up to a certain fixed limit for all sizes will constitute the quantity billed in the second block of the rate schedule.

"Service Charge" rates are in fact two-part rates in that the rate schedule consists of a uniform or graduated charge varying with the size of meter or service plus an additional charge for all water used, as computed according to the schedule of output charges. The additional charge for water used may also be subject to a uniform or graduated minimum. Some service charges consist of only a nominal charge which could generally be considered sufficient only to cover

customer costs such as meter reading, billing, collecting and accounting, whereas other charges are of a higher level and may cover some of the fixed charges on the investment in service and meter, or a portion of the "capacity" costs of a water works distribution system that exist by virtue of its state of readiness to supply service whenever requested. As can be noted from Table 2 various combinations of service charges with minimum charges are applied. Out of 376 schedules only 6 contain neither. The remaining 16 schedules made no statement regarding service or minimum charges.

The more prevalent form of rate is the minimum bill type. This comprises 78 per cent of the total examined. Only 12 per cent were of a service charge type, 8 per cent were combined service charge

TABLE 3

Percentage Distribution as to Types of Rate Schedules

SIZE OF CITIES	EXTENT OF SAMPLE*	TYPE OF RATE SCHEDULE			
		Minimum Bill	Service Charge	Combination	Neither
	%	%	%	%	%
500,000 and over	77	60	20	20	—
200,000–499,999	68	68	16	16	—
100,000–199,999	69	70	19	11	—
50,000– 99,999	62	72	10	16	2
20,000– 49,999	43	83	13	3	1
10,000– 19,999	30	82	9	6	3
Total	41	78	12	8	2

* Approximate per cent of total U. S. cities included in this analysis.

and minimum charge, and 2 per cent made no provision for either. The percentage distribution as to types in the various population groups is shown by the summary in Table 3.

A definite trend can be observed in cities larger than 50,000 population for decreasing prevalence of the minimum bill type of rate as the cities increase in size, although 60 per cent of the rate schedules for cities in the first group (over 500,000 population) were still of a minimum bill type. In general, as cities increase in size a larger proportion use the service charge type of rate although there is approximately an equal trend toward the use of a combination minimum bill and service charge. The provision of neither a minimum or service charge appeared only in cities smaller than 100,000 population.

Graduated Minimum Bills or Service Charges

Increasing the minimum bill or service charge for the larger meters or service connections reflects an attempt to apportion equitably among the water users the so-called capacity and customer costs. The variously called "capacity," "demand" or "ready-to-serve" costs depend largely on the rate of use of water during a given time interval rather than upon the volume of water taken. They consist of the operating expenses and fixed charges, such as depreciation, interest and taxes, necessary to have water supply and pumping equipment and distribution mains of sufficient size to maintain water in the mains at pressures sufficient to meet the demands for water at any time. Customer costs, on the other hand, depend chiefly on the number of customers served. These consist of such

TABLE 4

Per Cent of Rate Schedules with Either Graduated Minimum Bill or Service Charge

POPULATION GROUP	PER CENT
500,000 and over	70.0
200,000-499,999	63.2
100,000-199,999	61.1
50,000- 99,999	61.7
20,000- 49,999	48.7
10,000- 19,999	40.8
Total	50.5

expenses as meter reading, billing, collecting, keeping the customer's account, and recording maintenance and fixed charges (depreciation, taxes, interest or return) on special investment, principally service pipe and meter, for a customer. Customers requiring larger meters or services, who might have a large demand for water at any time, necessitate greater investment per customer than the small user. A graduated minimum or service charge for these larger users enables a water department or company to collect from such users more of the costs for which they are responsible, especially in the event that such customers make a relatively small use of their potential demand.

The extent to which water works systems have adopted either graduated minimum or service charges is shown by Section *B* of Table 2. On a percentage basis this analysis appears in Table 4.

It can readily be observed that the larger water utilities have more extensively incorporated the graduated feature than have the smaller. From 60 to 70 per cent of utilities in cities larger than 50,000 population have adopted this feature whereas in the lowest group, 10,000 to 20,000, the percentage drops to 40. A detailed study also shows that nearly 90 per cent of the service charge type of rates employ the graduated feature.

Blocking

Most water utilities charging for water according to meter registration use a single schedule for all classes and sizes of users. Because of the importance of fixed costs, consumers with a large volume of use, or more accurately a longer hours' use of their demands, may be supplied at a lower unit cost per 1000 gallons or per 100 cu. ft. sold. Moreover large users of water may be in a position to meet their requirements from a private well or other source of supply. To adapt a single rate schedule to these varying sizes and classes of users requires "blocking," that is, charging for larger uses of water at lower prices per unit.

An analysis of the number of blocks used in quoting the schedule of output charges is presented in Section *C* of Table 2. Only cities with a block rate, as distinguished from a step rate, were included in this summary. An example may be helpful to distinguish the two types:

Block Rate

First	5,000	cu.	ft.	used	per	quarter,	12¢	net	per	100	cu.	ft.
Next	15,000	"	"	"	"	"	9¢	"	"	"	"	"
"	80,000	"	"	"	"	"	7¢	"	"	"	"	"
All Over	100,000	"	"	"	"	"	6¢	"	"	"	"	"

Step Rate

From	0	to	5,000	cu.	ft.	per qt.	15¢	"	"	"	"	"
Over	5,000	"	20,000	"	"	"	12¢	"	"	"	"	"
"	20,000	"	100,000	"	"	"	9¢	"	"	"	"	"
	100,000	cu.	ft.	or	over		7¢	"	"	"	"	"

Under the above schedules the bill for a consumption of 30,000 cu. ft. per quarter would be $26.50 on the block rate and $27.00 on the step rate (all at 9¢ per 100 cu. ft.). The regressive feature of a step rate is illustrated by the fact that the bill for a consumption of 4,900 cu. ft. would be $7.35 and for 5,100 cu. ft. would be $6.12.

The most frequently used blocking is 3, although the frequency is

heavily centered around 3, 4, 5 and 6, with 6 the least frequent of the four. These four lengths comprise 61.1 per cent of the total of all schedules, and 65.6 per cent if one-block rates, which are in fact straight-line rates, are omitted. Out of 392 cases, straight-line or one-block rates account for only 6.6 per cent. Although not a very out-standing tendency, as cities increase in size, they tend to use fewer blocks. This is indicated by the median size of block for each population group. The median and mode for the groups are shown in Table 5.

A higher median than mode for the two lower population groups is due to the larger proportion of schedules having many blocks; also in most groups, the mode cannot be considered as a distinct and

TABLE 5

Number of Blocks Used by Population Groups

POPULATION GROUP	NUMBER OF BLOCKS	
	Median*	Mode†
500,000 and over	3	3
200,000–499,999	4	2
100,000–199,999	4	3
50,000– 99,999	5	5
20,000– 49,999	5	3
10,000– 19,999	5	3

* The size of block in which falls the median or mid-item when all are listed in an ascending array.

† The size of block which represents the largest number of cases.

outstanding mode, as some of the other lengths of blocks have practically the same number of cases.

Out of 392 schedules, 30 or about 8 per cent were step rates or rates which can be considered a regressive type. It is not stated whether customers are billed strictly on the basis of the step rates as quoted or whether no higher bills are charged than would result from the application of the rate schedule to a larger consumption. It is known that in some cases the latter method of billing is followed in the application of step rates. No step rate schedules appear in the two largest size population groups. In addition to the step rates noted, a combined form of block and step rate was found in 7 cases. With this combination customers are billed on a block rate up to a specified consumption, above which the total use by the customer would be billed at a uniform rate per unit of consumption.

Frequency of Billing

Table 2 *D* presents an analysis of the frequency of billing. With the exception of cities of 10,000 to 20,000 population, the frequency of billing is about evenly divided between monthly and quarterly. The five groups of cities comprising all cities over 20,000 population indicated 100 schedules with monthly billing and 97 with quarterly billing. For cities 10,000 to 20,000 the ratio was nearly 2 to 1 in favor of monthly billing. Slightly more than 10 per cent of the schedules analyzed provided for several methods of billing depending upon the class of customers or service supplied. These were all a combination of monthly and some longer period, the monthly applying to industrial service and customers with large consumptions, while the longer period applied primarily to residential and commercial customers.

Graduated Minimum Bills and Graduated Service Charges

No attempt has been made to compare the relative levels of water rates for the separate groups of cities. This involves a comparison of bills for various consumptions or types of customers, and to make the comparison consistent, considerable information would be necessary as to the conditions and characteristics under which service is supplied in each community. The comparisons of bills would be affected by such factors as the proportion of investment contributed by the customers, the source of supply, method of pumping, and characteristics of the distribution system. An analysis was made, however, of those rate schedules providing for graduated minimum bills or graduated service charges. The two objectives of the analysis were: (1) to determine the extent to which several meter sizes are combined in the schedule of graduated charges; and (2) to find the relative scale of graduated charges for various sizes of meters or services.

Combining of Meter Sizes

The great majority of meters and services are generally $\frac{3}{4}$ in. or less in size. On a theoretical cost basis, the $\frac{5}{8}$-inch and $\frac{3}{4}$-inch service connections or meters, and $\frac{1}{2}$-inch where used, each warrant a different minimum or service charge if the customer's potential demand and carrying charges on special customer investment are given full weight. As a practical matter, however, it appears likely

that the small differences in size of the smaller services and meters do not uniformly reflect correspondingly different demands, and that they could reasonably be combined.

From Table 2 it can be noted that 187 rate schedules were of a type which contained a schedule of graduated minimum or service charges. Definite information was available for 185 on the extent to which

TABLE 6

Combinations of Meter Sizes Used in Quoting Schedules of Graduated Minimum or Service Charges

NATURE OF COMBINATION	FREQUENCY
Most common combinations:	
$\frac{5}{8}''$ and $\frac{3}{4}''$	22
$\frac{1}{2}''$ and $\frac{5}{8}''$	13
$\frac{1}{2}''$, $\frac{5}{8}''$ and $\frac{3}{4}''$	7
$\frac{1}{2}''$, $\frac{5}{8}''$, $\frac{3}{4}''$ and $1''$	7
$1\frac{1}{4}''$ and $1\frac{1}{2}''$	4
Miscellaneous combinations:	
$\frac{5}{8}''$, $\frac{3}{4}''$ and $1''$	1
$\frac{1}{2}''$ to $2''$, inclusive	1
$\frac{3}{4}''$ and larger	1
$1''$ and $1\frac{1}{2}''$	2
$1''$, $1\frac{1}{4}''$ and $1\frac{1}{2}''$	2
$1\frac{1}{4}''$, $1\frac{1}{2}''$ and $2''$	1
$2''$ and $3''$	2
$4''$ and $6''$	2
$2''$ and larger	1
$3''$ and larger	2
$4''$ and larger	2
$6''$ and larger	3
$8''$ and larger	1
Total	74*

* 55 or 29.7 per cent of the 185 rate schedules of the graduated minimum or service charge type contained the 74 combinations listed; only 35 of the rate schedules included a rate for $\frac{1}{2}''$ meter, and 40 included a rate for $1\frac{1}{4}''$ meters.

meter or service sizes are combined. The combinations existent and their frequency are shown in Table 6. Seventy per cent of the schedules make no combination. The 55 that did, listed 74 combinations. The most frequently combined sizes are the sizes below 1 in., and even in some cases including 1 in. The two sizes, $\frac{1}{2}$ in. and $1\frac{1}{4}$ in., are used rather infrequently, only one-fifth of the schedules

under study making provision for these sizes. Eighty per cent of those quoting a rate for a $\frac{1}{2}$-inch meter, combined the size with one or more of the next larger sizes. Two-thirds of those that make any combination whatsoever, have combined the $\frac{5}{8}$-inch and $\frac{3}{4}$-inch meters, in some cases also with the next larger sizes. One-fifth of all schedules of the graduated type in some manner combine the $\frac{5}{8}$-inch and $\frac{3}{4}$-inch meters. Only 7 schedules based the graduated charge on the size of service in lieu of the size of meter.

Level and Relative Scale of Graduated Minimum or Service Charges

A comparison of the graduated charges, primarily for the purpose of showing the level of such charges, would not be wholly significant unless at least the investment required of the customer were taken into account. Some utilities will bear the expense of meter, meter installation and service from main to curb with only a nominal tapping fee, whereas in other cases the customer is required to bear these costs. In the analysis of graduated charges made in this study, the emphasis has been placed on determining the relative scale of graduation and the relation of charges for one size to the charges for other sizes. Nevertheless, the analysis of graduated minimum and service charges, as contained in the rate schedules applied, will point to the average level of such charges paid by customers in their current water bills. The averages also afford significant comparisons as to the level with different types of rates. The charges used in this study are those applying to service within city corporate limits.

Table 7 shows the average graduated charges per quarter for three groups of rates: (1) those having graduated minimum charges; (2) those having graduated service charges; and (3) those having both minimum and service charges, either or both of which may be graduated. It can be observed that graduated service charges are lower than graduated minimums. This is to be expected since no charge for water is included with the service charges. The combined charges for those schedules providing both a service and minimum charge are also lower than the graduated minimum bills, but higher than the service charges. The deviations from a definite trend in the third group are probably due to the small sample available.

A comparison is also noted on Table 7 of the comparative level and relationship between minimum bills and service charges for corre-

sponding meter sizes. Graduated service charges on the average show a trend to approach more closely the graduated minimum charges as the size of connection increases. The average service charge for a $\frac{5}{8}$-inch meter is 41.6 per cent of the corresponding minimum whereas for a 6-inch meter it is 75 per cent. This is probably due to the decreasing influence that "customer" costs and the charge for water may have on the determination of the minimum charge as the size increases. The graduated charges for the third group are, roughly, from 85 to 95 per cent of the graduated minimum charges.

TABLE 7

*Schedule of Average Graduated Minimum or Service Charges—Quarterly Basis**

SIZE OF METER	TYPE OF RATE SCHEDULE				
	(1) Graduated Minimum†	(2) Graduated Service Charge‡		(3) Graduated Service Chg. plus Minimum or Graduated Minimum§	
		Amount	Per cent of (1)	Amount	Per cent of (1)
$\frac{5}{8}$″	$3.00	$1.25	41.6	$2.55	85.0
$\frac{3}{4}$″	3.48	1.50	43.1	3.15	90.5
1″	5.40	2.50	46.3	4.18	77.5
$1\frac{1}{2}$″	9.00	4.50	50.0	7.50	83.3
2″	12.00	6.90	57.5	11.18	93.2
3″	21.00	13.50	64.3	18.38	87.5
4″	30.00	21.60	72.0	28.98	96.6
6″	54.00	40.50	75.0	59.80	110.7

* The median has been used as the average.

† This column covers a sample of from 101 to 118 schedules, depending on size of meter, out of 119 of this type.

‡ This column covers a sample of from 35 to 41 schedules, depending on size of meter, out of 41 of this type.

§ This column covers a sample of from 18 to 24 schedules, depending on size of meter, out of 27 of this type.

Probably the most significant aspect of average graduated charges for the various sizes of meters is the relative scale of graduation and the relationship of the charge for one size to that for another. This is conveniently shown by placing the average charges on a factor basis using the average for a $\frac{5}{8}$-inch meter as 1.0. These scales are shown in Columns B, D, and F of Table 8 for the three groups of graduated charge types of rates.

It is also interesting to compare the relative scale of graduated charges to the relative scale of theoretical discharges or potential

demands that are possible with the various sizes of meters or services. The factor scale of theoretical discharges is shown in Column A of Table 8. The percentage relationships shown in Columns C and E were arrived at by comparing the respective factor ratios of "quarterly charge" and "theoretical discharge" for each size of meter. These percentages result in an interesting curve when plotted with the respective sizes of meters represented. It should be borne in mind, however, that these "theoretical discharges" do not necessarily coincide with actual demands.

TABLE 8

Relative Scale of Graduated Minimum Bill and Service Charges

SIZE OF METER	THEORETICAL DISCHARGE OF CONNECTION*	GRADUATED QUARTERLY CHARGE				
		Minimum Bill		Service Charge		Types Having Combinations of Both
		Factor	Per cent of Col. A.	Factor	Per cent of Col. A.	
	A	B	C	D	E	F
$\frac{5}{8}$″	1.0	1.0	100.0	1.0	100.0	1.0
$\frac{3}{4}$″	1.6	1.2	75.0	1.2	75.0	1.2
1″	3.3	1.8	54.5	2.0	60.6	1.6
$1\frac{1}{2}$″	9.0	3.0	33.3	3.6	40.0	2.9
2″	18.3	4.0	21.9	5.5	30.1	4.4
3″	50.1	7.0	14.0	10.8	21.6	7.2
4″	101.7	10.0	9.8	17.3	16.9	11.4
6″	273.2	18.0	6.6	32.4	11.9	23.5

* Discharge in cu. ft. per min., 40 to 50 lb. pressure, 100 ft. service pipe, no back pressure. *Kent's Mechanical Engineer's Handbook.* John Wiley, New York. (10th ed.), p. 760.

Average Length of Blocks

With nearly two-thirds of all rate schedules consisting of either 3, 4, 5 or 6 blocks, it would seem useful to determine the average quantity of water included in the respective blocks of rate schedules of these types. It is generally recognized that an increase in consumption results in a decreasing cost per unit of water sold, especially if consideration is given to the charges borne directly by the consumers. In short, a rate schedule with graduated service or minimum charges and graduated commodity charges will more closely approximate the typical cost curve for varying outputs in industries or utilities requiring relatively large amounts of fixed investment,

such as a water works system, than schedules not having these characteristics.

A summary of the average lengths of blocks, including also schedules with only two blocks, is given in Table 9. The lengths of blocks indicated, in effect, amount to a composite average rate schedule for each separate type. The size of blocks for individual schedules vary

TABLE 9

Average Length of Blocks in 2-, 3-, 4-, 5- and 6-Block Rate Schedules

NUMBER OF BLOCKS IN SCHEDULE	SIZE OF BLOCK—CUBIC FEET PER QUARTER					
	1st†	2nd	3rd	4th	5th	6th
	average length (median)					
2 block rates	18,000	18,000*				
3 " "	10,000	50,000	60,000*			
4 " "	7,250	12,750	55,000	75,000*		
5 " "	5,000	5,000	39,000	121,000	170,000*	
6 " "	4,000	6,000	16,667	53,333	120,000	200,000*
	average length (arithmetic mean)‡					
2 block rates	39,000	39,000*				
3 " "	12,800	49,200	62,000*			
4 " "	8,100	20,500	71,300	99,900*		
5 " "	5,900	7,800	39,800	140,900	194,900*	
6 " "	3,600	8,000	19,900	50,900	128,200	210,600*

* The limit above which all consumption falls in the last block.

† The average length of the first block does not include those rate schedules which include a specific allowance of water for the minimum charge or in which the total charge for water in the first block corresponds with the minimum charge. All schedules were, however, used in computing the average length of the other blocks. The average lengths of the first block of the rate schedules excluded from this analysis are noted in Table 10.

‡ The average used represents an arithmetic average of the middle 50 to 60 per cent, a range including an equal number of items above and below the median and excluding an equal number of the lowest and highest items. The averages were rounded to the closest 100.

between wide limits. For this reason, it was believed that a median average would probably be the most practical and of greatest value since with this average there are an equal number of schedules with blocks shorter and longer than the average. An arithmetic average has also been computed of the size of blocks of the middle 50 to 60 per cent. The range used includes an equal number of items above

and below the median, and excludes an equal number of the shortest and longest size blocks. The arithmetic average is naturally somewhat higher than the median, but limitation to the range of the middle 50 to 60 per cent to a considerable extent excludes the unbalancing effect that long blocks and high items may have on the arithmetic average.

The computations of average size blocks were made on the basis of the total consumption at which the rate schedule broke into the next size block. For example, the average length of the third block was found by deducting the average total of the first two blocks from the average total of the first three blocks. In this manner average size blocks are secured which will tie in with each other and which will

TABLE 10

*Average Length of First Block of Rate Schedules Providing a Specific Allowance of Water as Included with the Minimum Charge**

NUMBER OF BLOCKS IN RATE SCHEDULE	PER CENT OF TOTAL SCHEDULES	CUBIC FEET PER QUARTER		
		Median	Arithmetic Mean	Range
2 block rates	34.5	1,500	1,545	500-3,000
3 " "	20.9	1,350	1,619	500-4,000
4 " "	19.2	1,000	1,398	280-4,500
5 " "	31.5	1,000	1,209	400-3,000
6 " "	17.0	1,000	1,362	600-3,000

* Also including those schedules in which the total charge for water in the first block corresponds with the minimum charge. For those schedules that provide for specific increases in the amount of water as the graduated minimum charge increases, the minimum allowance used was that for a $\frac{5}{8}$" meter.

represent a composite schedule of rates. It will also give effect to any tendency there may exist for rate schedules in general to break at certain levels of consumptions which may represent, roughly, the requirements of various classes of customers such as residential, commerical, industrial or manufacturing.

The rate schedules were separated into two groups in computing the average length of the first block. Rate schedules which include a specific allowance of water with the minimum charge would naturally not have as long a first block as rate schedules not of this type. The average lengths for first blocks shown in Table 9 do not include rate schedules of the "specific allowance" type which represent nearly one-fourth (23.8 per cent) of the total included in this analysis. The

average lengths of the first block for the "specific allowance" type of rates are shown in Table 10. All schedules were, however, used in computing the average length of the other blocks.

Some interesting observations can be made from the averages. The size of the first block decreases progressively as more blocks are adopted. The last block of the 4-block rate is from 25 to 50 per cent higher than the last block of the 3-block rate, and most of the difference is accounted for in adding a rather short second block. The first two blocks of both the 5- and 6-block rates are short blocks. The last block of the 5- and 6-block rates are about equal and are two to three times the size of the last block of the 3- and 4-block rates. The 6-block rate includes a rather short third block similar to a second block for the 4-block rates.

Public Fire Protection Service

It is generally recognized that water utilities furnish two major classes of service: water for general use by residential, commercial and industrial customers; and public fire protection service. Private fire protection service may in a sense be considered a combination of both, in that, while the public may be benefited through having fires controlled without spreading, the individual customer also receives personal benefit, primarily through savings in fire insurance premiums.

Because the same water works system is jointly used to furnish these two major services, the total cost of service should be divided and a reasonable portion assigned to and charged for public fire protection service. The task of dividing the total cost of service between the two major uses has always been a rather perplexing one. Furthermore, there is a difference of opinion as to the form or type of rate by which the costs of supplying public fire protection service should be recovered. An attempt has been made to determine the prevailing methods of charging for this class of service and the relative level of charges for the most common methods.

A tabulation of the methods is given in Table 11. One-fifth of the cases under study made no statement regarding this type of service. Of the 316 cases giving information, 162 or 51.3 per cent make no annual charge. This reflects the extent to which water works systems are still regarded as a part of the governmental operations of municipalities and hence no attempt is made to conduct operations as a city-owned business enterprise. A number of regulatory bodies

having jurisdiction over municipally owned water works systems and many municipalities themselves have taken the initiative to place municipally owned water works systems on an operating basis distinct and separate from strictly governmental operations and to make charges for public fire protection service. In this respect a trend is apparent for a larger proportion of the smaller size communities to make charges than the larger communities. The percentage of total

TABLE 11

Methods of Charging for Public Fire Protection Service
United States Cities 10,000 Population and Larger

METHOD OF CHARGING	NUMBER OF CASES
1. No charge	162
2. Per-hydrant charge	110
3. Specified annual sum	11
4. Per-hydrant charge plus charge per lineal foot of main	11
5. Combination of (3) and (4)	6
6. Combination of (3) and (2)	3
7. Based on charge per "inch-foot" of main*	3
8. Per-hydrant charge, graduated with number of hydrants	2
9. Based on charge per lineal feet of main	2
10. Cost of maintenance and repair plus 10 per cent	2
11. Based on charge per-capita	1
12. Per-hydrant charge plus "inch-foot" charge for main	1
13. Based on allocation of plant	1
14. Based on a uniform added tax rate	1
	316†

* In this form of charge a constant rate is applied to the total product of feet of main as multiplied by the respective diameters.

† No information as to public fire protection was available on the other 77 cities included in the study.

communities in each group making charges for public fire protection service is as follows:

Cities, 500,000 and larger	37.5%
200,000–499,999	41.2"
100,000–199,999	40.6"
50,000– 99,999	47.2"
20,000– 49,999	51.1"
10,000– 19,999	51.8"

Out of 154 cases that make a charge, as shown in Table 11, 110 or 71.4 per cent charge on a per-hydrant basis. The various other methods can be noted from the table.

The level of the per-hydrant rates is shown by the summary in Table 12.

Since a number of the municipally owned systems indicated that the rate charged was only what could be termed a nominal bookkeeping entry, it was believed useful to have separate averages for municipally and privately owned plants. The per-hydrant rate for the privately owned plants on the average appears about $10 per hydrant per year higher than the charge for municipally owned plants. This is also borne out by the range of the middle 50 per cent which tends to exclude the extremely high and low items. The charges for private plants also do not vary between as wide limits as the charge for municipal plants.

Private Fire Protection Service

It is generally recognized that private fire protection service is a specific class of service supplied by a water works system. In many decisions of public utility commissions and in many court opinions† it has been pointed out that a peculiar personal service is provided for a customer's benefit with a private fire protection connection, which service is not enjoyed in common by the community as a whole except as it benefits from reduced fire hazards. Except in case of fire, the water used through such connections is negligible, but the utility is required to have adequate capacity in its plant to furnish water under adequate pressure in its mains to meet these demands

† *In Re Appl. Oconto City Water Supply Co.;* 7 W.R.C. 497. *In Re Invest. Ashland Water Co.;* 14 W.R.C. 1. *Mfgrs. Ass'n. of Kenosha* v. *City of Kenosha;* 22 W.R.C. 440. *Re Appl. Racine Water Dept.;* 5 P.S.C.W. 354. *Gordon & Ferguson* v. *Doran;* 100 Minn. 343 (111 N.W. 272). *Cox* v. *Abberville Furniture Factory;* 75 S.C. 48, 54 S.E. 830. See also Indiana Public Service Commission's report in *Com'l Club* v. *Terre Haute Water Works Co.;* P.U.R. 1916, B. 180–215.

The following statement from *Water Works Practice.* American Water Works Association, New York, 1929, pp. 617–8 is also significant:

"With relation to decisions affecting private fire service protection, there is an apparent unanimity of opinion by courts and public utility commissions to the effect that a water utility, which supplies water for private fire protection purposes, performs a service which is in addition to supplying water for public fire protection, and the water utility has a right to make a reasonable charge for private fire protection service."

whenever they occur. Consequently the costs of private fire protection service are predominantly capacity or stand-by costs. It is questionable whether such connections would be made or continued unless the charges made for the service were less than the savings in insurance premiums plus the fixed charges and maintenance of the customer's investment in the sprinkler system. At the same time the rates must not be so low as to place on other users an unreasonable share of the costs incident to such service.

Types of Rates

An analysis of the 393 cities examined indicates exceedingly diverse methods of charging for this class of service. The various methods and their frequency are listed in Table 13. The most obvious aspect is the lack of uniformity and the difficulty of grouping or classifying the various types.

TABLE 12

Analysis of 110 Rate Schedules Applying a "Per Hydrant" Charge for Public Fire Protection Service

GROUP OF CITIES	AVERAGE*	RANGE	RANGE OF MIDDLE 50%
All 110	$30.00	$5.00-$100.00	$20.00-$40.00
Municipally owned systems (88)	25.00	5.00- 100.00	18.00- 40.00
Privately owned systems (22)	35.00	12.00- 60.00	25.00- 50.00

* The median was used as the average.

No information as to charges or the supply of this class of service was given by one-fifth of the cases studied. It is probable that a large number of these may not have private fire connections and hence have not adopted rates or regulations on supplying the service. Approximately one-third of utilities reporting information make no charge. The balance, 206, have been grouped into three general types: (1) charges on a flat rate and unmetered basis, 81; (2) charges based primarily on a schedule of graduated service charges depending on the size of connection, 79; (3) variations of metered and combinations of metered with flat rates, including graduated minimum charges, 44; and (4) miscellaneous, 2.

The number of cities in the second group, having schedules with graduated service charges and variations thereof, is about the same as the total in the first group having variations of flat rate charges. The two groups together account for three-fourths of all types of such

TABLE 13

*Methods of Charging for Private Fire Protection Service**

METHOD	NUMBER OF CASES
Number reporting no private fire protection systems	2
Method of charging not stated	78
No charge for service	107
Some charge made for this class of service	206
Total	393
Methods of Charging	
Flat Rate Basis:	
Per hydrant charge; sprinkler system charge based on no. of heads	22
Charge per sprinkler system only was mentioned†	18
Charge per private hydrant only was mentioned‡	15
Charge per hydrant; per sprinkler system charge	17§
Single service charge (all sizes of connections)	6
Per-hydrant charge; service charge on sprinkler system	1
Per-hydrant charge; graduated minimum for sprinkler	1
Flat rates with graduated minimum based on size of connection	1
Graduated Service Charges:	
Graduated service charge based on size of connection	50
Per hydrant charge; graduated service charge for fire services	18
Graduated service charge plus per hydrant charge and charge for sprinkling system	5
Graduated service charge plus metered charge for water	3
Graduated service charge; per hydrant charge plus metered	2
Graduated service charge plus charge for sprinkler system	1
Metered (Variations of):	
Billed on regular meter rates	23
Hydrant flat rate; sprinkler system metered	5
Hydrant metered; sprinkler system flat rate	3
Single service charge plus metered	3
Hydrant metered; sprinkler system no charge	2
Sprinkler system metered; hydrants no charge	2
Graduated minimum charge plus metered	2
Metered but no charge for water used for fighting fires	1
Graduated minimum charge; metered plus charge for sprinkler system	1
Graduated minimum charge; metered, sprinkler heads not metered.	1
Single minimum plus 20 per cent of regular rates	1
Miscellaneous:	
Based on value of building	1
Graduated min. charge; sprinkler system charge varies with character of building	1

* This covers an analysis of all 393 cities included in the study.

† Two cases specifically stated no charge for private fire hydrants.

‡ Six cases specifically stated no charge for sprinkler systems.

§ Includes 3 which also have a graduated minimum charge varying with the size of connection.

charges where made. The remaining one-fourth consists primarily of variations of charges on a metered basis. Approximately one-eighth of the flat rate and graduated service charge schedules also grant the option of taking the service on the basis of the metered rates or of combining private fire protection service with general service.

Of the individual types, the type of rate found applied to a greater extent than any other is a schedule of graduated service charges based on the size of connection. This one type represents nearly one-fourth of all those reported. This type is also found in combination with additional charges such as charges per hydrant, per sprinkler system or for sprinkler heads.

Level and Relative Scale of Charges for Private Fire Protection Service

A study was also made of the average level of charges for those utilities making charges for this class of service. The averages could be computed for only the more prominent types of rates for which a representative sample was available. Averages were computed for: (1) the group of schedules consisting of a graduated service charge; and (2) the group consisting of unmetered charges, limited to those applying a per-hydrant, per-sprinkler system charge or charge based on the number of sprinkler heads.

The analysis of graduated service charges was prepared with two objectives: first, to find the average level of charges for each size of connection; and second, to determine the relative scale of graduation and relation of charges for one size to those for another.

The average annual service charges for the various sizes of connections, as shown by a study of 68 cases, are shown in Table 14. A consistent graduated schedule can be observed from the table. The frequency with which the various sizes of connections are used in quoting rates is also indicated. The average charges for the 10- and 12-inch connection may not be representative due to the small sample available.

Inasmuch as not all schedules provide for charges for each size, and since the schedules of charges are of different levels it was believed that a more significant scale or index of the average relationship of charges between sizes of connections could be determined by computing the factor or percentage ratio that each of the charges in a schedule bore to that for one size. For this purpose the charge for a 4-inch connection was used as a base. The average factor index

from this analysis is shown in Table 15. The index of average factor ratios presents a well balanced scale of graduated charges, increasing with the size of connection. With the exception of the 10-inch size, the median falls in a group having more than one item. The

TABLE 14

Average Annual Service Charges for Private Fire Protection Service

SIZE OF CONNECTION	NUMBER OF SCHEDULES INCLUDING CHARGE FOR THIS SIZE CONNECTION*	AVERAGE ANNUAL CHARGE†
1″	16	$10.00
1½″	23	13.50
2″	50	20.00
3″	47	30.00
4″	64	42.50
6″	64	60.00
8″	46	96.00
10″	20	110.00
12″	11	144.00

* Out of a total of 68 cases analyzed.

† The median was used as average.

TABLE 15

Relationship of Average Graduated Service Charges for Private Fire Protection Service to Charge for 4″ Connection

SIZE OF CONNECTION	AVERAGE FACTOR INDEX*	FREQUENCY DISTRIBUTION OF CASES		
		Below Median	Same as Median	Above Median
1″	.200	7	2	7
1½″	.375	10	4	7
2″	.500	18	20	9
3″	.750	24	15	11
4″	1.00	†	†	†
6″	1.50	20	14	28
8″	2.50	21	5	18
10″	3.54	10	—	10

* The median is used as the average and in all sizes except for 10″ falls in a group of more than one item.

† The 4″ size was used as a base and other sizes were related to the charge for this size.

frequency distribution, as related to the group including the median, is also shown, and serves as an indication of any tendency that may exist for the normal charges of a certain size connection to be somewhat higher or lower than the average factor index indicated in the

table. For example, although the average ratio of the charge for a 2-inch connection is indicated as being 50 per cent of the charge for a 4-inch connection, 18 schedules had a percentage lower than this, and only 9 higher, the other 20 falling exactly on the percentage. From this distribution it might be concluded that average or normal charges for a 2-inch connection are somewhat less than 50 per cent of the charge for a 4-inch connection.

TABLE 16

Average Flat Rate Charges for Private Fire Protection Service

AVERAGE CHARGE OR RANGE OF CHARGES	PER PRIVATE HYDRANT*	PER SPRINKLER SYSTEM†	PER SPRINKLER SYSTEM—NO. OF HEADS‡						
			200	500	700	1000	1500	2000	3000
Average (Median)	$30.00	$25.00	$22.50	$25.00	$35.00	$50.00	$75.00	$100.00	$150.00
Mode	40.00	25.00	10.00	25.00	35.00	50.00	75.00	100.00	150.00
	percentage distribution of charges in relation to mode								
Lower than mode	58.2§	36.0	7.4	8.1	25.9	26.9	38.4	38.4	42.3
Mode	17.9	25.0	29.6	48.2	44.5	57.7	46.2	46.2	46.2
Higher than mode	23.9	44.0	63.0	40.7	29.6	15.4	15.4	15.4	11.5

* Assumptions made on certain schedules; charge for initial hydrant used in a graduated schedule; yard hydrant used in contrast to wall; 2-way hydrant used if other types mentioned. The analysis covers 67 cases.

† Rates quoted as "per system," "per installation," "per service" or "per connection" considered as synonymous. The analysis covers 25 cases.

‡ Bills were computed for each size of installation noted according to the charge based on the number of heads. The analysis covers 27 cases.

§ The percentage distribution of charges per private hydrant in relation to the median are: below 43.3 per cent, median 9.0 per cent, higher than median 47.7 per cent.

The index of average factor ratios could serve as a convenient guide to the establishment of a graduated schedule of service charges for the various sizes of connections, once the relative level of a charge for 4-inch connection has been determined. It is also possible to interpolate this schedule to some other size as the base. The average factor index from the analysis is shown in Table 15.

The four methods of flat rate charges most frequently found as shown by Table 13 were analyzed to determine the relative level of

such charges. These comprise 69 cases. The following three averages were determined and are summarized on Table 16: (1) average charge per private hydrant; (2) average charge per sprinkler system for schedules of this type; and (3) average charge per installation of various number of sprinkler heads where the rate is based on the number of heads.

For the average of these rates, both the median and the mode are indicated. The modal item is the same as the median except for the "per-private-hydrant" average and average charge for a sprinkler installation of 200 heads. The frequency distribution of cases lower and higher than the modal average is also shown and serves as an indication of any tendency that may exist for average or normal charges to be somewhat higher or lower than the averages indicated.

Thirteen of the 27 schedules that base the charge for a sprinkler system on the number of heads contain a minimum bill provision ranging from $15 to $60 per connection, system or installation with a median average of $27.50.

Conclusion

On the whole, it would seem that the averages indicated by the study should be reasonably representative of all cities in the United States of 10,000 population or larger.

It is believed that much of the summarized material presented in this study will be useful in the design or revision of rates for water service, and will serve as criteria of present practices in water rates.

Certain conclusions emerge from this statistical study. These may be summarized as follows:

1. The water rate structure of American cities is simple with respect to classifications of service but diverse and largely unstandardized with respect to type of rate schedule, except as to use of a minimum bill or service charge. Charges for private fire protection service, where made, are even more varied than for general metered service.

2. The predominant type of schedule consists of minimum bills, plus output or commodity charges with from 3 to 6 blocks. About half the rate schedules with minimum bills or service charges are graduated, chiefly according to size of meter.

3. Larger cities are more prone than smaller cities to use a schedule with graduated minimum or service charges. This reflects a tendency to apportion costs more equitably and precisely among various

sizes and kinds of water uses, and to have fewer blocks in the output charge.

4. Billing periods are about equally divided between the month and the quarter.

5. There is a considerable tendency to overlook or neglect the cost of public fire protection service with a possibility that such costs are met from general service revenues, to the extent that they are covered by any water utility revenues. Larger communities are greater offenders than smaller communities in this respect.

6. The predominant type of charge for public fire protection service is per hydrant, but the level of such charges by public plants at least raises questions whether all the costs attributable to such service are covered by the charge.

7. When charges for private fire protection service are made, they are exceedingly diverse in type, but may be grouped roughly into unmetered flat charges, unmetered graduated charges and metered service.

8. Water utilities as a group might derive great benefit from joint efforts to study the bases of charging for water service, and the opportunities and economies of securing greater uniformity and standardization of water rates.

Organizing to Prevent Fires

By Percy Bugbee

IT SEEMS self-evident that there is a very strong natural mutual interest between the American Water Works Association and the National Fire Protection Association. Every water works man has to concern himself with problems of furnishing water for fire protection purposes. Every fire protection man is necessarily concerned with the adequacy of water supply for his community or for his specific place of business.

It is interesting to recall that in 1925 joint fire prevention committees were formed in both the United States and Canada, made up of equal representatives of the American Water Works Association, the National Fire Protection Association, and the International Association of Fire Chiefs. Representing the A. W. W. A. on the United States committee were A. W. Cuddeback, J. E. Gibson, Nicholas Hill, H. F. Huy, and F. C. Jordan. The committee was formed primarily to establish closer relations between city fire and water departments and to develop and encourage a closer understanding of the mutual problems of these two important city administrative services. The joint committee developed a tentative platform of desired accomplishments, which platform was adopted at the annual meetings of all three of the organizations concerned. This platform included, among other things, the encouragement of the general use of sprinkler systems by cities, the adoption of adequate fire protection legislation, and the creation of local fire prevention committees in each community.

The recommendations of that joint committee are largely applicable today. It is still highly desirable that there be close cooperation between water works men and fire departments in their respective

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communities. It is still most desirable for the water works men in any community to take an active part in local fire prevention effort.

The fire waste situation in this country is still disgraceful. We burn to death every year in the United States from 10,000 to 12,000 men, women and children and we cripple and injure nearly 17,000. We destroy property worth approximately $300,000,000 every year. Perhaps the most tragic thing about this is that for the most part deaths and injuries by fire are due to simple, everyday known acts of carelessness. People die every day by dropping off to sleep in bed with a lighted cigarette in their mouth or in their hand. People die every day because they try to quicken the fire in the coal stove by pouring kerosene on it. Children die every day because their parents let them play near an open fireplace or a bonfire.

We have not solved the fire waste problem in this country. We need the help of everyone and certainly we need and want the help of the A. W. W. A. because of its direct and natural interest in control of fire waste.

There are certain major trends in the fire loss picture that should be appreciated. The trend of losses is away from the cities to some extent and toward the farm and rural communities. Losses on farms and in unprotected areas are staggering. Another trend of great concern is the baffling problem of the apparent continual increase in the number and seriousness of fires in dwellings. Why is it that a man will take the necessary precautions to protect his store or factory against fire, but will ignore the simple precautions necessary to protect his own family? The great public of this country is yet to be made fire conscious to a sufficient extent and the N. F. P. A. and others concerned in the field are moving heaven and earth to make the rank and file of the citizens of America more conscious of the simple facts about control of fire. It can readily be shown that this consciousness is the determining factor. During Fire Prevention Week which the N. F. P. A. sponsors and which is very widely observed, the records indicate that losses drop the week prior to Fire Prevention Week, are quite low during the week and the week after, but thereupon rise to their normal weekly average. A great disaster in a school or apartment house brings about an immediate reaction which definitely reduces the number of fires in schools or apartment houses as the case may be.

It seems desirable to recite very briefly some of the activities of the N. F. P. A. in controlling fire waste.

Practically all of the standards for the control of fire are developed

through the 46 technical committees of the N. F. P. A. An enormous amount of time and effort is put into the creation of standards and the refinement of existing standards every year. The technical committee work has long been the backbone of our activity, but to go along with it new avenues to spread this desirable information through efficient channels have been developed. The N. F. P. A. has organized, for instance, all of the state and Canadian provincial fire marshals and the fire marshals of the larger cities of the country into one section. These men are on the firing line when it comes to enforcement of legislation, investigation of arson and kindred matters, and the exchange of information between them is of vital importance.

Because of recognition of the trend of fire losses to the rural areas, there has been organized a Volunteer Firemen's Section through which all of the 13,000 volunteer fire departments throughout the United States and Canada are given information pertinent to their work. This development, which is only seven years old, has proved enormously useful in spreading the fire protection gospel into the highways and byways of America.

One effective method has been found to attack the dwelling house fire problem and that is through the annual inspection by firemen for the simple hazards in all homes. Hundreds of cities are now undertaking this inspection. It is hoped eventually to develop the idea until it becomes a common practice in every community, large and small.

There has been a tremendous growth in the past decade in the more adequate training of firemen. Forty-three of the forty-eight states carry on state-wide training programs to which any fireman in the state may come and receive valuable instruction at little or no cost. The N. F. P. A. has served as a coordinating agency in this development, believing that it is is one of the most hopeful developments in fire waste control.

Adequate legislation to control fire is of vital importance. Through association activities, a model arson law has been adopted in forty-two of the forty-eight states and now a vigorous campaign is under way to achieve support for a model state fireworks law, already adopted in nine states. The N. F. P. A. actively encourages the adoption of local building codes and fire prevention codes for the control of hazards, and many of the technical standards developed by the association are suitable for enactment into local or state legislation.

Such is a brief general picture of fire waste and some of the things that are being done about it. Let us consider, now, a couple of matters of more specific concern and interest between the two associations.

A part of the cost of the public water system is that which may be assigned to fire protection. In small cities, the cost of fire protection is a large proportion of the total cost. In large cities, it tends to be a small part of the total, but whether large or small, the rate structure should provide that the municipality reimburse the utility for the fire protection service. Too many cities expect the water utility to make up this factor of cost as best it can from its income from domestic users.

In giving fire protection service, most water works would regard their share of the work done when they bring water to the property line. At this point the fire department can get at it through the hydrants when needed for fire fighting.

For fires in small buildings like dwellings, this is enough. But for buildings of large height and area and combustible contents, it does not apply. It would not be true for a skyscraper office building, for a department store, or for a furniture factory, for instance. The ordinary method of fighting a fire is to run a line of hose from a hydrant to the fire, trying to get the water somewhere near where the fire can be seen. For occupancies such as those mentioned, such a method has been demonstrated to be inefficient. It is inefficient even when the hose lines are in the hands of the best fire department in the country. For such fires, something more than hose lines from the street are required.

For skyscrapers, the problem has meant the installation of standpipe systems. For factories, the water mains have been extended from the street to a private system of mains and hydrants. Even such measures alone do not bring the water close enough to the location of a fire. Automatic sprinkler systems do accomplish this; especially in buildings of large size with quick-burning contents, sprinklers are essential if there is any assurance to be had that the fire may be controlled.

When the N. F. P. A. was organized one of its purposes was to study the operation of sprinklers. For forty-four consecutive years the performance of these systems has been carefully observed. From this background, sprinklers may be shown to be the most important single type of private fire protection. In over 96 per cent of thousands and thousands of cases in our files, sprinklers check or control

the fire. It is estimated that they reduce losses due to fire and water from 80 to 90 per cent.

With so nearly a sure method of fire control, the importance, in our eyes, of securing the widest possible use of automatic sprinklers is obvious. Naturally, water works everywhere are helping to increase the use of sprinklers by making connections to property owners on the best terms possible. This is an enlightened self interest as sprinkler systems tend to reduce materially the fire demands on water systems. Top demands for fire flow in a principal mercantile district are about 20,000 gal. per min. Occasionally fires require greater rates of flow. The Chicago stockyards fire demanded 50,000 gal. per min. In contrast, a building or group of buildings sprinklered needs only 1,000 to 2,000 gal. per min. maximum.

The N. F. P. A. Committee on Public Water Supplies for Private Fire Protection has made the recommendation that property owners pay for making connections to the public system when sprinklers or other protection are connected to it. In general, this is the only substantial expense these connections place on the water utility. If an annual charge is made thereafter, it should be on the basis of actual cost of inspection or supervision. This actual cost is so small that most water works make only a nominal annual charge. A recent survey covering 847 water works showed that 481 make no charge at all and that 75 per cent of the others make only a nominal one.

Another recommendation of the committee suggests means of controlling water waste from these connections. In very large buildings or industrial plants with complicated yard systems, it is often necessary to meter the connection. There are other situations where detecting devices may be used in place of meters. Especially in the case of connections to automatic sprinkler systems only, there are many situations which require no meter.

Annual charges imposed for fire connections are exorbitant only in certain parts of the country such as the northern New Jersey area, and up to recently, the San Francisco Bay district. Meter requirements are for the most part reasonable. Where complaint may be made, it is usually due to the application of a requirement which gives the property owner only one means of controlling water waste. I have in mind those utilities which call for a fire service meter on all connections. Such a requirement makes the connection prohibitively expensive in small properties. Our position is that measures required for control should be appropriate for the particular case. This requires some discrimination. Calling for a meter in

every and all cases avoids discrimination, but it causes hardship in individual cases.

Obviously, unjustifiably high charges and indiscriminate meter requirements tend to stand in the way of sprinkler and other installations of fire protection, and because of that the N. F. P. A. does what it can to influence more desirable practices from its point of view.

To give point to what has been said above, some mention should be made of a comparison, which our engineering department made, of cities in Massachusetts and New Jersey. The requirements on fire connections in Massachusetts cities are generally very reasonable and fair. In New Jersey the requirements are high. The results indicated by this survey contrast the effect of these two policies. In the principal mercantile districts of Massachusetts cities, there are many sprinkler systems and the percentage of built-on area sprinklered is high. In the same districts of New Jersey cities, sprinkler systems are relatively few and far between.

Since private fire protection is essential if disastrous fires and losses of life are to be avoided, the vital interest of our Association in moving to get these charges and meter requirements on an equitable basis is readily seen.

There is one other matter that should be mentioned briefly. The N. F. P. A., in 1913 and 1914, adopted specifications for fire hydrants. These were designed to produce a hydrant free from most of the defects common to hydrants then in use. Among the difficulties were trouble in opening and closing, the working loose of mechanical parts, leakage, excessive friction losses, failure to drain properly, etc. The principles outlined in these specifications, with minor modifications in construction details, form the basis of the present practice of Underwriters' Laboratories and the Factory Mutual Laboratories in the listing of hydrants approved by these laboratories.

Specifications for hydrants were adopted in 1913 by the A. W. W. A. and revised in 1916. In many details the two specifications of the A. W. W. A. and N. F. P. A. are in substantial agreement. There are minor differences, however, in certain provisions. It is pleasing to note that the N. F. P. A. and A. W. W. A. committees having this subject in charge have been working toward harmonizing the two requirements. There should not be such a wide difference of opinion over a technical matter of this character.

In conclusion, the author would like to place additional emphasis on the mutual interests of the N. F. P. A. and the A. W. W. A.

The Water Works' View of the Use of Public Water Supplies for Private Fire Protection

By Reeves Newsom

IN THIS discussion I am not outlining my personal opinion nor any official position of the American Water Works Association with regard to the use of public water supplies for private fire protection. Rather, I am approaching the matter from the same point of view as did Mr. Bugbee in his address to the convention of the A. W. W. A. at Kansas City in April. If cooperation is to be had between the two associations, if an intelligent effort is to be made toward a workable middle-ground position regarding charges for private fire service, then each group must know how the matter appears to the other and in all fairness must try to understand the other fellow's problem.

Therefore, I will attempt to report to you the viewpoint of water works men, regarding private fire protection service and charges, as I have heard it expressed under various circumstances by numerous representative men of the water supply field.

The water works operator considers private fire service:

1. A specialized service with the possibility of high capacity demand but ordinarily requiring very little water.

2. A standby service to be used without any notification or any control by the water works, and thus a poorer load than industrial standby or emergency services where notice of intent to use can often be given.

3. When used through sprinklers, as an important means of stopping fires in their early stages and thus of general benefit to the entire community; but a type of fire service required under special circumstances of size and arrangement of property, and required most where a special risk has been created by the customer.

A paper presented at the Convention of the National Fire Protection Association, Atlantic City, N. J., May 8–11, 1940, by Reeves Newsom, Engineer-Consultant, New York City. Published by permission of Percy Bugbee, General Manager, N. F. P. A.

4. A fire service which is not in lieu of public fire service and one which, in the case of a very bad fire, represents an excess load at the time of maximum fire demands from the public fire-fighting apparatus.

5. A rate problem, which, however resolved, must be considered in the light of a plant's entire schedule of charges.

All fire service represents primarily the holding in readiness of a sufficient capacity of pumps, filters, clear wells, equalizing reservoirs, transmission mains, distribution mains, including principal feeders and minor distributors, hydrant connections and hydrants so that, when occasion demands, water can be delivered at high rates of flow for short periods and in quantities which, because of the concentration in a restricted area, are very large compared to what is ordinarily being delivered. When it is considered how much of the time, thought and effort of a water-works operating force is spent in collecting, purifying, pumping and delivering potable water and in the measuring, charging and receiving payment for the water furnished, it is easy to understand that the water works man isn't too pleased with the efficiency of the fire service end of his business. About a third of all the money invested in his plant is used to deliver less than one per cent of the water. From the viewpoint of the man whose life's work is furnishing a dependable supply of finely conditioned water, it is certainly a case of the tail wagging the dog.

When a customer wants a private fire service connection he is requesting a type of standby service through which only a very small amount of water will be required to do the work which is expected of it. But it will come into use automatically without any knowledge or control by the water works operator and while highly efficient, if it fails in its purpose, it may become a load on top of the very peak of the demands otherwise put on the system and at a time when the community just can't afford to have the water system fail.

The water works operator, schooled as he is in thinking that to whatever extent is humanly and financially possible he must provide water service under all reasonable combinations of contingencies, cannot adopt the premise that sprinkler service is a substitute for the demands of public fire service. He is accustomed to thinking in terms of the rare situation that might cause his service to fail, because he realizes that water service is the most fundamental of utility services and the one upon which all other utilities and the continuation of urban existence depends.

He cannot get away from the consideration of that combination of circumstances wherein broken sprinkler lines, in buildings which have collapsed, throw a serious additional demand on the water system at the point where, and at the time when it can least afford to be subjected to such a load. The knowledge that these conditions are doubtless less likely to occur in the future, and will probably be less a problem in proportion to the number of sprinkler connections installed in the community, does not remove from the water works man the responsibility of attempting to take care of that ultimate contingency which he may have to face if things that have happened in the past in certain localities are repeated in his community.

In some locations it is not entirely a matter of the load resulting from broken sprinkler lines at the time of a fire. The experience of certain cities during the floods of the last decade has shown another condition where buildings, moved from their foundations, have left open lines which tended to drain the water system at a time when the amount remaining in storage was priceless.

It is not surprising, therefore, that the water works official seeks to hold down the size of the sprinkler connections that are made to the mains, nor that he desires to charge a compensatory amount for the service and the problem which a great number of such connections can cause. He knows that he is responsible for the most vital of all public services and that the greater the catastrophe the more essential it is that water service, both domestic and fire, does not fail.

It is very difficult for a water works man to agree that private fire protection is in all respects but an extension of public fire protection; that all the needed facilities are already present for the furnishing of private fire service; and that inasmuch as general fire protection is something to be paid for by the municipality as a whole, there should be no charge to the individual who desires private fire service. Private fire service customers require public fire protection service and in addition, because of the size, shape and arrangement of their properties, they need other facilities to get water to certain vital points.

While it is recognized that, from some points of view, private fire service can be considered an extension of public fire service, from the viewpoint of payment for the service, such an assumption adds an argument for the making of substantial charges rather than for their elimination. It is a well-known fact that payment for public fire service, almost without exception, does not compensate the

water utility for its investment or for the expense it incurs for that purpose. An allocation of costs as between domestic and fire service will, under most circumstances, show that from 25 to 40 per cent of the total revenues of a water system should come from charges for fire service. Where payment is made to private companies for this service, such payments generally fall within a range of from 7 or 8 to about 15 per cent of the total revenue. In those municipally owned plants where the charges for public fire service and for taxes on the water works plant are assumed to offset each other, there is present about the same relative error, inasmuch as the taxes, if assessed on the property within the municipality, would, on the average, probably require materially less than 15 per cent of the department's revenues.

When it is proposed, therefore, to extend fire protection service to particular properties and to make little or no charge for such service on the theory that it is an extension of the use of facilities which have already been paid for, the theory and the facts do not square with each other and the water works operator cannot reasonably be expected to agree to such an attitude.

To say that a sprinkler connection is merely another opening by means of which the capacity of the water system to furnish fire protection is made available where it is most needed and that it should not, therefore, be the cause of any additional substantial charge does not appeal to the water works man because in the majority of cases the charge for public fire protection is increased whenever another hydrant is added. This appears only proper inasmuch as the number of hydrants used, multiplied by the rate charged per hydrant, never equals the amount of money that should be received in view of the facilities that must be available to render this type of service.

In theory, if public fire protection is paid for on the basis of inch-feet of capacity in the main pipe system plus nominal charges to cover hydrant installations, the charge for a sprinkler connection should also be a nominal one. Unfortunately, however, the total of the charge made on the inch-foot basis again does not equal the total amount that should be received in proportion to the facilities devoted to fire protection service.

If a water system is designed and built with sufficient capacity, properly located, to furnish the required number of effective fire streams in proportion to the character of the hazards present at a time when a sizeable number of 4-, 6- or 8-inch sprinkler lines are

running wide open, if the charge for public fire service is based primarily on the inch-foot or other unit of main capacity and if the total amount paid or allowed by the municipality is in fair proportion to the part of the plant constructed for fire service purposes and aggregates from 25 to 40 per cent of the total water revenue, then, and only then, would the water works operator agree to the contention that the only charge that should be made to the individual for private fire service is one covering interest, depreciation and the cost of maintenance of the connection and the occasional inspection of the connection and the premises.

Even if fire protection charges were adequate to compensate the water works for the service rendered, there remains the question of whether or not the taxpayers as a whole should carry the cost of special service to a relatively few individuals. But that is a matter of general policy which can be settled by the municipal authorities without affecting the water works operator. He probably would not be interested in how the expense of fire service was spread among those receiving it if he received in total the proper amount for the facilities and service provided by his plant. The general consumers of water would then be paying a rate based upon the cost of the service they were receiving and there the interest of the water works operator in individual rates would cease.

The number of consumers who require private fire service is not large in proportion to the total in a community, but the number of domestic consumers is large and their complaints because of the size of water bills are continuous. The water works operator desires, when he can, to improve his plant and facilities and the quality and dependability of the water supply. And he desires to reduce the rates to consumers when he can do so, consistent with keeping up the standards of service. He is human and would like to make a reduction to as many consumers as possible and particularly to those to whom utility service charges are a real problem.

How can he reasonably be expected, therefore, to have much sympathy for a movement to eliminate sprinkler charges?

Here is a special type of customer, one usually of some size, who desires to have a special connection which will make large savings to him in insurance. He wants to take advantage of the fire service capacity of the water system in a special way, not instead of the public fire service, but generally in addition to it. He wants an extension of the general fire service to meet a particular hazard which he has created or which is inherent in his business. Although the savings

are so substantial to him, running as high as a 90 per cent rebate on his premiums, that he is willing to pay the going price for the equipment he has to install, he doesn't want to contribute any more toward the upkeep of the water works plant than the hundreds of water consumers who have no such fire protection problem.

Furthermore, the water works operator knows that it isn't just the premium savings on his insurance against damage by fire that this particular customer is interested in. It is also the loss of business following a fire which he probably wouldn't be insured against that he wants to prevent by stopping any fire in its incipiency. So he asks for an extension to his property, with little or no charge, of a type of service which is not paying its way. A considerable proportion of the cost of this service is already being carried by the general water user whose rate is being maintained at its present level because he is carrying part of the other fellow's load and the water works operator is prevented from lowering it for that very reason.

How can the latter be expected to be enthusiastic about eliminating the sprinkler connection charge and taking a further step in enlarging the injustice already existing?

In many cases the private fire service charges of a water company have been set by a commission or court after protracted and costly litigation. Under regulation by public service commissions the amount of return a particular property is entitled to is determined both as to total and as to how it shall be spread among various types of consumers.

No one class of charges can be changed or eliminated and spread on other types of consumers without a probable examination of the entire rate structure and the allied questions of value and return—often a lengthy and expensive proceeding. A water company, therefore, is faced with that as one alternative and the absorbing of the loss in revenue as a result of reducing or eliminating sprinkler charges as the other.

Inasmuch as either alternative leads to making worse what is already a badly unbalanced rate set-up, it is not reasonable to expect a water company manager to be very keen about becoming involved in any activity toward disturbing private fire service rates which have been previously established or approved by the regulatory body having jurisdiction.

Charges for private fire service do not constitute one of the large items of the total revenues of a water system, and by and large they

are not considered a field to exploit for the purpose of increasing the income. One test of the water works operator's position, however, is to consider the effect of a complete reversal. Suppose that water works officials decided that the way to solve this particular problem of rates and revenues was to charge a small rate for private fire protection and to build up a large volume of business. Suppose they encouraged everyone to put in 6, 8 or 10-inch connections, as many as they thought they needed without regard to the size of the mains to which they were tapped or the general gridiron in the part of the city involved. It may be predicted that the most prompt and loudest protest would come from the interests represented by the N. F. P. A. It seems obvious that there is a position better than either extreme.

The average water works man realizes that it is unwise to antagonize important industrial interests in his community by attempting to charge all the traffic will bear in the light of the savings in insurance premiums on the part of the sprinkler users. But, on the other hand, he has firm convictions against rendering special service involving some risk and added capacity and spreading the cost over small consumers already paying more than their share. He is entitled to have his opinion considered and it would seem equally unwise for the N. F. P. A. to antagonize water works officials by trying to force through the proposition of rendering private fire service with substantially no compensation.

The insurance people desire, in their interest, to extend the number of automatic sprinklers. They will find fewer obstacles to their plans if they court the cooperation of water works operators because the latter are not basically opposed to rendering this service. They do, however, resent any inference that they are indifferent to losses of life and property from fire, particularly when they believe that, in seeking adequate payment for fire service so they can install sufficient added capacity to keep ahead of the demands, their purposes are just as humanitarian as are those who are seeking to prevent bad fires. Furthermore, water works men believe that the individual who is going to save sufficient to justify his paying what it costs to install sprinklers is not going to be deterred from proceeding by a reasonable charge for the water service, which, after all, is the most important element in the whole situation.

It appears fairly obvious that if the National Fire Protection Association desires to be even more constructive in its efforts to lower

the charges for private fire protection, it would do well to use its influence toward the correction of the fundamental difficulty of the whole situation. If it desires to have the position adopted that private fire protection, being an extension of public fire protection, should carry only a nominal charge, efforts to bring about the proper payment for public fire protection would accomplish much toward enlisting the cooperation of the water works operator. Certainly more progress would be made than by the procedure of attempting merely to lower or eliminate charges for private protection service without any concern as to the source of the alternative revenue. It is very difficult for the superintendent of a water department or the manager of a water company to prevail upon the administrative officials of a municipality to increase tax rates for the purpose of more equitably spreading the charges as between fire protection and domestic water service. This association no doubt recognizes that the failure of water works to receive adequate compensation for fire protection service with the present undesirable alternative of loading the costs of such service into the water bill of the domestic consumer is one of the greatest stumbling blocks towards the extension of fire service facilities, both public and private, with which it has to contend.

If the argument which has been advanced, that private fire service is a part of the general fire service of the community, differing primarily in its method and point of application and that all fire service is of so much benefit to the community as a whole that its reasonable extension will pay dividends, directly or indirectly, to all the inhabitants thereof, was forcefully presented to the public officials who are responsible for municipal budgets, it would be directed to those who are in a position to do something to correct the situation. To present this to a water works operator with the expectation of prevailing upon him, first to eliminate his charge for private fire service and then to attempt, single-handed, to recover the lost revenue by increasing the charge for public fire service, or failing that, to increase general water rates, is to overestimate the results of the misapplication of what may well be a perfectly logical argument.

It is my firm belief that there is no good reason why the two associations, which have much in common, cannot work out an equitable approach to the problem of using public water supplies for private fire protection. As a representative of the water works operators and engineers, I appreciate this opportunity to present something of our view of the situation.

The Texas Fire Insurance Department

By Albert R. Davis

EVERY water works man is concerned with having a water works system that is adequate. Adequacy means that: (1) the water must be potable; (2) the supply must be abundant; (3) the plant and lines must be designed with sufficient capacity to supply the maximum demand to be anticipated—that maximum demand naturally includes water for fire fighting purposes; and (4) there must be a trained organization to construct and operate. It may be asked how adequacy concerns fire insurance, and it is this question that the paper will attempt to answer.

In the design, construction and operation of a system, there is a point of economic balance where the cost of installation is justified by the revenue received or by the savings that can be made. It is, therefore, incumbent upon the superintendent and the engineer, charged with the responsibility of producing water service, to so design, construct and operate that dividends will be paid on the investment. In order to do this, certain facts regarding the cost of fire insurance must be ascertained and applied. It has been no small task to find the necessary information and to apply the proper values to it. The determination of this information has fallen largely to fire insurance rating bureaus of various distinctions. Every state in the Union has faced this problem and has taken steps to solve it. In Texas, this work is a function of the Fire Insurance Department of the Board of Insurance Commissioners. This duty is so closely interwoven with its other functions that it is necessary to explain somewhat the law creating the Department.

The law establishing an insurance commission went into effect on July 1, 1913. The old inadequate law governing insurance matters was not replaced until a very careful study had been made of condi-

A paper presented on April 23, 1940, at the Kansas City Convention by Albert R. Davis, Superintendent, Water Department, Austin, Texas.

tions existing in other states. Texas was faced with a peculiar problem of her own; namely, a large number of small towns in territory bearing three classifications—wet, semi-arid, and arid. East Texas has an average rainfall of 50 inches; Central Texas, 30 inches; and West Texas, 10 inches. In 1910, there were no towns in Texas with a population of more than 100,000, but approximately 600 of smaller size. In view of these facts and findings, the present law was passed. The Commission does not claim that the law is a panacea for all fire insurance ills, but it does believe it has many admirable features worthy of consideration. A democratic law is considered to embody the thought "of the people, by the people, and for the people." This law is typically democratic. It is reminiscent of the story of the Englishman who, when asked if he didn't think the Constitution of the United States was a wonderful document, replied, "It *is* wonderful the way you damned Americans make it work." A law that receives the support of the policyholders and the fire insurance companies must have something "on the ball." This one has a record of 27 years of successful operation.

In creating the Board, the law was specific in its provision for personnel and terms:

"There shall be three members of said Board, one of whom shall be known as the Life Insurance Commissioner, who shall be chairman of the Board; there shall be a Fire Insurance Commissioner, and there shall be a Casualty Insurance Commissioner. . . . The regular terms of said officers shall run for six years and appointments made in such manner that each member shall serve six years, and one membership of the Board shall expire every two years. . . . Vacancies shall, with the advice and consent of the Senate, be filled by appointment by the Governor."

Briefly, the duties of this board are to see that all laws concerning insurance are faithfully executed. Following are excerpts from the insurance laws of the State of Texas, which will give a comprehensive idea of the functions of the Fire Insurance Department:

"*Art. 4878. Commission Shall Fix Rates.* The State Insurance Commission shall have the sole and exclusive power and authority and it shall be its duty to prescribe, fix, determine and promulgate the rates of premiums to be charged and collected by fire insurance companies transacting business in this State. Said Commission shall ascertain as soon as practicable the annual fire loss in this State; obtain, make and maintain a record thereof and collect such data

with respect thereto as will enable said Commission to classify the fire losses of this State, the causes thereof, and the amount of premiums collected therefor for each class of risks, and the amount paid thereon, in such manner as will aid in determining equitable insurance rates, methods of reducing such fire losses and reducing the insurance rates of the State, or subdivisions of the State.

"*Art. 4879. Maximum Rate Fixed.* A maximum rate of premiums to be charged or collected by all companies, as herein defined, shall be exclusively fixed and determined and promulgated by the State Fire Insurance Commission, and no fire insurance company shall charge or collect any premium or other compensation in excess of the maximum rate. . . .

"*Art. 4881. Statements and Books.* Said Commission is authorized and empowered to require sworn statements for any period of time from any insurance company affected by this law . . . of the rates and premiums collected for fire insurance on each class of risks, . . . and said Commission is empowered to require such statements showing all necessary facts and information to enable said Commission to make, amend and maintain the general basis schedules provided for in this law and the rules and regulations for applying same, and to determine reasonable and proper maximum specific rates. . . .

"*Art. 4882. Schedule and Report.* The rates of premium fixed by said Commission . . . shall be at all times reasonable and the schedules thereof made and promulgated . . . shall be in such form as will . . . most clearly and in full details disclose the rate so fixed and determined . . . to be charged and collected for policies of fire insurance. . . .

"*Art. 4884. Analysis of Rate.* When a policy of fire insurance shall be issued by any company transacting the business of fire insurance in this State, such company shall furnish the policyholder with a written or printed analysis of the rate of premium charged for such policy, showing the items of charge and credit which determine the rate. . . .

"*Art. 4886. Reducing Hazard.* The Commission shall have full authority and power to give each city, town, village or locality credit for each and every hazard they may reduce or entirely remove, and also for all added fire fighting equipment, increased police protection, or any other equipment or improvement that has a tendency to reduce the fire hazard of any such town, city, village, or locality, and also to give credit for a *good fire record* made by any city, town, village or locality. Said Commission shall also have the power and

authority to compel any company to give any or all policyholders credit for any and all hazards that said policyholder or holders may reduce or remove. Said credit shall be in proportion to such reduction or removal of such hazard, and said company or companies shall return to such policyholder or holders such proportional part of the unearned premium charged for such hazard that may be reduced or removed.

"*Art. 4887. Revising Rates.* The Commission shall have authority after having given reasonable notice, not exceeding thirty days, of its intention to do so, to alter, amend, or revise any rates of premium fixed by it.

"*Art. 4889. Standard Forms.* The Commission shall prescribe all standard forms, clauses and endorsements used on or in connection with insurance policies.

"*Art. 4892. Complaints of Rates or Orders.* Any citizen or number of citizens of this State or any policyholder or policyholders, or any insurance company affected by this law, or any Board of Trade, Chamber of Commerce, or other civic organization, or the civil authority of any town, city or village, shall have the right to file a petition with the State Insurance Commission, setting forth any cause of complaint that they may have as to any order made by this Commission, or any rate fixed or determined by the Commission and they shall have the right to offer evidence in support of the allegations of such petition, . . . and the said petition shall be set down for a hearing at a time not exceeding thirty days after the filing of such petition and the Commission shall hear and determine said petition; but it shall not be necessary for the petitioners or any one of them to be present to present the cause to the Commission, but they shall consider the testimony of all witnesses, whether such witnesses testify in person or by depositions or by affidavits, and if it is found that the complaint made in such petitions is a just one, then the matter complained of shall be corrected or required to be corrected by said Commission.

"*Art. 4896. Duty of Fire Marshal.* The State Fire Marshal, at the discretion of the board, and upon request . . . shall forthwith investigate at the place of such fire before loss can be paid, the origin, cause and circumstances of any fire occuring within this State, whereby property has been destroyed or damaged, and shall ascertain if possible whether the same was the result of an accident, carelessness or design, and shall make a written report to the Commissioner.

. . . When, in his opinion, further investigation is necessary, he shall take or cause to be taken the testimony on oath of all persons supposed to be cognizant of any facts, or to have knowledge in relation to the matter under investigation, and shall cause the same to be reduced to writing, and if he shall be of the opinion that there is evidence sufficient to charge any person with arson, or with attempt to commit arson, or of conspiracy to defraud or criminal conduct in connection with such, he shall arrest or cause to be arrested such person, and shall furnish to the proper prosecuting attorney all evidence secured, together with names of witnesses and all information obtained by him, including a copy of all material testimony taken in the case, and it shall be the duty of the State Fire Marshal to assist in the prosecution of all such complaints filed by him.

"*Art. 4902. Tax on Premiums.* The State of Texas shall assess and collect an additional one and one-fourth per cent of the gross . . . premium of all companies doing . . . business in this State, . . . and said taxes when collected shall be placed with the State Treasurer in a separate fund which shall be known as the Fire Insurance Division Fund, which fund shall be kept separate and apart from other funds and moneys in his hands; and said special fund . . . shall be held and expended for the purpose of carrying out the provisions of this Chapter."

To handle the immense amount of detail work that falls to the Fire Insurance Department, it has been necessary to organize a force of inspectors, clerks, engineers, etc. according to functional requirements in the following divisions: (1) rating; (2) fire prevention; (3) licensing; (4) actuarial; and (5) engineering.

The rating division, headed by a supervisor of rates, handles the details connected with the promulgation of rates to be charged for fire insurance on mercantile and special class risks—such as manufacturing—and on buildings of a public nature. A special file is kept of each individual risk outlined above, and it is estimated that they now number 750,000. Maps are also kept showing the location and construction of all rated risks. These maps are made on scales of 1 in. to 100 ft. and 1 in. to 50 ft., and show the location and size of water mains, and location of fire hydrants and exposures.

At stated intervals, towns and cities are inspected by the rating division inspectors to check the accuracy of file records and maps maintained by the rating division and to bring them up to date.

Local agents, requesting a rate for a rated risk, submit, with their

request, a sketch showing the location and surrounding exposures. This information is checked against the office maps and any additional information given by the local agent is added to the map record. Insurance agents are permitted, with certain restrictions, to apply rate schedules to residences.

The main office of the fire insurance commissioner is located in Austin, Texas. This office is open to the public during all business hours, and any individual may secure orally or in writing any desired information as to rates charged or improvements to be made in improving any individual risk—such as the installation of chemical extinguishers or automatic sprinklers—or any change in the hazard of an individual risk.

The Fire Prevention Division is charged with the investigation of fires of a suspicious nature. Arson bears a part in the rating of cities, and proper facilities for thorough investigations are essential. This division is also charged with the supervision of the teaching of fire prevention in the public schools.

The licensing division deals with the issuance of licenses to local fire insurance agencies and agents, together with their solicitors. Certain requirements listed by law have been set up, and the licensing division supervises the enforcement of the law acting through the members of the insurance commissions.

The actuarial division is charged with the compilation of data regarding the premiums collected and the losses paid in the various classes of risk. This division passes upon the various forms and warranties, and their application to the various insurance policy contracts.

Under the direction of the chief engineer, the engineering division is charged primarily with making such investigations as will show the ability of a city or town to handle fires. Items such as water works, fire departments, fire alarms, police departments, fire marshal, building law, streets and alleys, and conflagration hazards are considered in making a general classification of the city or town. This classification is known as the city "key rate."

The key rate represents the comparative ability of towns and cities to cope with fires in relation to a prescribed schedule. The work in this division compares with reports and gradings in cities made by the National Board of Fire Underwriters. It should be pointed out here that the grading schedule is comparatively simple and easily understandable, even to the general public which lays no claims to

being expert in insurance matters. It is also possible to determine from the engineer's report what corrections may be made and what corresponding reduction may be realized in the key rate. With this information available, it can be easily determined whether or not it is economical to make such corrections. The knowledge that a certain reduction in the key rate can be obtained has been the means of securing finances for improvement of fire fighting facilities. This is aptly demonstrated by the fact that all P.W.A. and W.P.A. water works applications must bear the approval of the Fire Insurance Department and the State Health Department.

The work of the engineering division is of prime interest to the water works design engineer, because it is here that he can ascertain the facts needed to design the necessary items and to leave out the unnecessary. It is through this division that he can secure information as to what reductions can be made in the key rate, provided certain improvements are made. It is here that he can also find out how much each cent saving on the key rate means to the policyholders of his city.

Fire protection and fire prevention are so closely allied that they are thought of almost collectively rather than separately. In studying the Texas Fire Insurance Law, the organization of the Fire Insurance Department, and the procedures in handling the work, there comes a realization of the enormous amount of effort that has been spent in molding the present law and organization. Without the help of the public the picture might be vastly different. And why has the public supported this law? The answer is very definitely found in *Art. 4886* of the law: "To give credit for a good fire record." To have a good fire record means much more than having a good water works, good firemen, etc. It means that the people of a city or town have a real desire "to keep the fire demon in chains." The writers of the law realized and appreciated this principle and decided to reward the city or town, that was willing to exert itself, by making up to a 25 per cent reduction on the annual fire insurance premium for a good fire record. As a further incentive, a maximum penalty of 15 per cent was added to the city with a bad record. The City of Austin with the maximum reduction in 1939 paid $327,724 in premiums. If the "good-fire-record" credit had not been given, premiums would have amounted to $435,632 and if the 15 per cent penalty had been added, the total would have been $500,977. The difference then, between the amount actually paid and that which

might have been is $173,252. This saving goes to the policyholders, and is a real incentive to a city to reduce all possible hazards and to keep continually "on its toes" in striving to prevent possible fire losses.

An old millionaire acquaintance of the writer once observed that there were two jobs that would ruin a young man—one was working for the government, and the other was working for a railroad—because in either position, the young man would be dealing in large sums of money and would be apt to lose sight of the penny and the nickel. Admitting the possibility of truth in this observation, let us consider the good fire record in school boy fashion, taking the case of two water works employees who live in different towns of equal fire fighting facilities and having the same key rate. The only difference is that town number one has a "25 per cent good fire record" and town number two has a "15 per cent bad fire record." Each man wants to carry $5,000 fire insurance on his residence.

	Town No. 1	Town No. 2
Basis	35	35
Roof	20	20
Key Rate	08	08
Total	63	63
Credits 10%	06	06
Annual Rate	.57	.57

Annual Premium: $5000.00 × 0.57 = $28.50 $5000.00 × 0.57 = $28.50
Good Fire Record: 25% credit—$28.50 × 75% = $21.37
Bad Fire Record: 15% penalty—$28.50 × 115% = $32.77

Difference in premiums paid $32.77 − $21.37 = $11.40
Town No. 2 pays 53% more than Town No. 1

Thus, the water works employee living in town 2 is forced to pay $11.40 more for his insurance than the other. The $11.40 is a real reward for a good record, and it is a reward in a substantial sort of way that the individual policyholder can understand.

From such evidence as this, it must be concluded that the Texas Fire Insurance law is based on fundamentally sound principles. As a result of such principles, the application of the law to the policyholders and insurance companies has been highly satisfactory.

Symposium on Recreational Use of Watersheds

By M. W. Cowles, Lloyd B. Sharp, William Banks, H. P. Croft, W. C. Mallalieu, Russell Van Nest Black, H. T. Critchlow, Mortimer M. Gibbons and C. P. Wilber

Introduction

By M. W. Cowles

SANITARY control of watersheds, from which public water supplies are drawn, is of great importance not only in densely populated New Jersey but elsewhere in the country. Watershed protection is essentially a broad public problem and close cooperation between all groups or agencies is becoming increasingly necessary. The widespread use of the automobile and the ability to go long distances in short periods of time, together with increased leisure time have accentuated the need for outdoor recreational facilities wherever available adjacent to centers of population—even on watersheds which serve as sources of public water supply. This demand for outdoor recreational facilities, "a move back to the good earth" as one speaker said, should provide necessary relaxation for city dwellers and can contribute much toward maintenance of true democracy.

A series of abstracts prepared by M. W. Cowles, Health Officer, Hackensack Water Company, New Milford, N. J. The papers were presented on February 7, 1940, at the New Jersey Section Meeting, New Brunswick, N. J., as a symposium, by Dr. Lloyd B. Sharp, Executive Director, Life Camps, Inc.; William Banks, Division Engineer, Newark Water Department (delivered by A. B. Anderson, Assistant Engineer, Newark Water Department); H. P. Croft, Chief, Bureau of Engineering, State Department of Health; W. C. Mallalieu, Sanitary Engineer, Jersey City Water Department; Russell Van Nest Black, Consultant Director, State Planning Board; H. T. Critchlow, Engineer, State Water Policy Commission (delivered by John N. Brooks, Assistant Engineer, State Water Policy Commission); Mortimer M. Gibbons, Sanitary Chemist, Newark, N. J.; and C. P. Wilber, State Forester and Director, Department of Conservation and Development. Mr. Cowles served as discussion leader.

Ponds or running water are naturally the attraction around which recreational facilities are focused. Some of these very streams and ponds, by necessity, must likewise serve in part as sources of water supply for our metropolitan centers.

To provide for conservation of our human and natural resources, some working relationship must be found for the uses of certain lands, where properly located, for forest and timber production, recreational uses and for water supply needs. Open spaces for recreational purposes are very limited in the metropolitan areas in New Jersey and the deficiencies are great. Ownership of a large proportion of a watershed yielding potable water leads to the view, on the part of the public, that such lands constitute a forbidden Mecca for outdoor recreation and in some cases the ownership stimulates a demand, unreasoning at times, for the use of some portion of such properties.

Recreational facilities of any kind can, in general, be so operated and constructed as to minimize the possibility of contamination of water supplies, but obviously some judgment must be used in the selection of sites. The water purveyor must provide suitable facilities for the purification of water used for potable purposes for protection, by remoteness alone, has disappeared. It is, therefore, probable that by means of a better mutual understanding of the problem, all of the groups which have an interest in recreation and water supply protection could profit by such a cooperative attitude. It was for this purpose that this symposium was held.

The contributions of the various participants have been abstracted. Certain repetitious material which was common to all the papers has been summarized in the foregoing statement.

Out on the Good Earth

By Lloyd B. Sharp

The theme, outdoor recreation, has profound implications when it is recalled that 55 per cent of our population resides in large cities in a congested pigeon-hole apartment life far removed from the influence of earth and nature. Is not this a reason for the urge to get outdoors and commune with nature?

True democracy cries out "everyone to the height of his individual capacity." We as a people may be misled by external signs for it is the deeper feelings that count. Opposition as indicated by the political parties set-up, is a wholesome thing, for its existence creates

thought for the presentation of facts. A decrease in self-direction may lead to overthrow of our laws based on the Constitution and the substitution of centralized control in one form or another. We must be able to think out our problems as a democracy. Population shift has an effect; youth is unnaturally restricted in its growth and so are we all. If there ever was a time for people to get "out on earth" it is now. To solve our problems, we must face the realities of life fairly and squarely, or else. . . .

On a thousand acre tract at High Point, New Jersey, Life Camps, Inc. has a unique demonstration area in that there is no crowding. The area includes some 45 single cottages, each with 8 children and 2 adults. In the camp, the children live and move about. The camp has its reforestation problems, a fire problem, a watershed problem and a swimming pool problem and all are exposed to the problems and their practical solution.

Four basic principles have been developed there:

(1) The planning and cooking of meals to stimulate private enterprise;

(2) The provisions of shelter, individually creative in contrast to life in an apartment, where even tools for minor repairs are not available;

(3) Self-occupation in finding interesting things to do and in learning in an unknown field, in contrast to the ever constant city-life;

(4) Spiritual development in the inspiration of natural beauties and impressions which it is impossible for children to understand in a great congested city.

A school for professional leaders for such camps is to be conducted this year for training of others to carry on the basic principles of "back to the good earth."

On the basis of experience with these problems of democracy and the need for beautiful outdoor living, the realization of the profound significance of such a meeting as this becomes obvious as a way to get all the issues clearly before the group with the hope that joint wisdom may lead to a happy solution of common problems. It is felt that every inch of open space, that can be made *safely* available, should be used for recreational purposes. The most profound situation can best be visualized around a camp fire and that is the place where sound thinking is of most interest and where democracy can be seen at its best.

ABSTRACTOR'S NOTE: There is an important inference here in the contrast of outdoor recreational facilities really adapted to the great open spaces with so-called recreational facilities consisting of clusters of small buildings on small lots, overcrowded on week-ends, approaching the congestion of the cities that the city-dwellers are trying to escape from for week-ends.

Need for Increased Space for Recreation

By William Banks

In the five years following 1889, the Pequannock Water system of Newark was developed. It includes five impounding reservoirs and 64 square miles of watershed. Much of the watershed was purchased until now some 89 per cent is owned. Houses were removed and open fields planted with pine and hardwood. The region was sparsely populated and inaccessible due to poor roads and lack of suitable vehicles, but the automobile and the construction of a state highway have removed this inaccessibility. The development of artificial lakes and other bodies of water adjacent to the watershed has been widely advertised, making motor traffic through the area heavy (on Sundays, 300 or more autos per hour). The city folks are looking for places to picnic in the open and such a tract of land in a beautiful setting is naturally appealing to the outdoor-minded public. The lure of the wide-open spaces is hard to resist and "no trespassing" or other signs are frequently ignored. Taxpayers in the City of Newark feel that the land belongs to them to use as they see fit, and frequently arguments with the watershed guards result.

In the early twenties, these factors became apparent and a change in policy was made necessary. Three definite areas were set up for the use of picnickers, thereby relaxing, in part, the policy of complete exclusion practised before. The sites were scenically attractive, well shaded, and, to minimize the possibility of contamination or pollution, remote from any reservoir or tributary stream. Three hundred cars and 1,000 people can be accommodated. Under the direction of uniformed guards, parking places are available, tables with fireplaces and plenty of wood, suitable containers for garbage and rubbish, and clean convenient chemical toilets. The guard exercises general supervision over the area.

Experience has indicated a considerable interest on the part of the visitor in the several glass covered maps containing information about the reservoirs and the water system and including treatment as well as the transmission mains to the City. Here is an opportunity for education which brings many questions, a feeling of the importance of the protection of the sources of the public water supply and a willingness to cooperate.

Jurisdiction over Sanitation of Recreational Places

By H. P. Croft

Certain statistical data upon the number of camps, recreational places other than camps, and swimming pools are available as of March, 1939, for the State of New Jersey.

Inspection records of the State Department of Health show that New Jersey has 151 summer camps for children or adults, or both, usually maintained in rural areas for profit or in connection with organization health and welfare programs. Thirty-five per cent of these were served by unsafe or suspicious private water supplies, the balance by private or public supplies. In 25 per cent of the camps, sewage and waste disposal was unsatisfactory. There is no statute which empowers the State Department of Health to enter into matters of sanitation inherent in camp location, construction or operation. Compliance must be obtained largely by the application of education or persuasion.

In 1932 and 1933, the Bureau of Engineering of the State Department of Health made an extensive survey of indoor and outdoor bathing places, excluding the ocean beaches, bays or tidal tributaries. Five hundred and ninety-three bathing places were located and inspected, 74 of the indoor type; 79 of the artificial, outdoor type; 26 of the semi-artificial outdoor type; 288 of the semi-natural; and 126 of the natural type.

Based upon the premise that for safe pool water coliform organisms should not be present in more than 30 per cent of the 10 ml. portions of pool water examined, about 66 per cent of the bathing places were found to be unsafe (97.8 per cent of semi-natural, 22 per cent of indoor).

The State Water Policy Commission authorized the construction of 40 dams from 1933 to March, 1939, for the creation of new recreational or swimming places.

Following the survey, the State Department of Health introduced in the Legislature, from 1933 to 1938, bills which had for their purpose the establishment of reasonable jurisdiction in location, construction and operation of swimming places. These bills failed to become a law, so it was concluded that the Legislature did not desire the State Department of Health to function in such matters.

Outdoor recreational facilities generally fall within three broad classes: (1) great natural features such as the ocean, bays, rivers and mountains, always available for many forms of use and enjoyment; (2) privately-owned and privately-maintained facilities financed by and available only to their possessors; and (3) public parks, playgrounds and other recreational areas and facilities provided by government agencies.

The greatest hazard to health exists at the recreational areas patronized by the public at large at the beach and lakeland areas. The State Department of Health exercises no organized sanitary supervision in these recreational areas.

On the basis of the existing statutes, but more especially in view of the absence of specific statutes and in view of the opinion of the New Jersey Court of Errors and Appeals, it is concluded that in the matters of the establishments of camps, swimming places or recreational centers, insofar as they affect public water supplies, the function of the State Department of Health is one of correction and not prevention. A further conclusion is that, in the matter of correction, the activities of the State Department of Health are controlled by the provisions of the act called "Pollution of Potable Waters," 58:10:1 Revised Statutes, Chapter 41, Laws of 1899 as amended by Chapter 229, Laws 1918.

Private Recreational Development and Public Health

By W. C. Mallalieu

In the privately-owned recreational development, over a series of years, a multiplicity of owners, each with a different purpose and widely varying ideas of sanitation, must be anticipated. Too frequently, these places are started with insufficient financial backing with the result that they are thrown open to the public with inadequate sanitary or other public protective measures. If the season

is good, the facilities may be completed the following year but only too frequently these facilities never pass beyond the stage of plans or hopes, yet the problems and the hazards still remain.

Prevention is elemental in present day public health procedure, yet one frequently hears the old legal maxim that a nuisance cannot be anticipated. Sanitary engineers can predict with reasonable accuracy the sanitary hazards which exist and which may ultimately take a toll of human life or misery.

A recreational development improperly located may affect the users of the premises or the riparian owners downstream or both, but these two phases may be quite different. Pollution of a private water supply on such a premise or improper discharge of sewage materials into the ground is one angle and pollution of a stream by such sewage may effect the bathing area as well as downstream owners.

The desirability of well constructed and well operated recreational developments, properly located, is admitted from the public viewpoint, yet it is essential to recognize the harm that may come from a proper object improperly placed.

There are areas where recreational centers can be established without causing, or becoming a potential source of, an injury to other users of the stream or to their patrons. To this end, it is proposed that some qualified state agency, be set up to pass on the following facts as determined for the particular parcel in question:

1. Necessity to be proven in connection with the existence of similar facilities nearby.
2. Proper design for the protection of owner, user and others.
3. Proper maintenance for the protection of user and others.
4. Adequate financial backing to insure proper completion.
5. Adequate protection (non-interference) for any public interest such as water supply.
6. Continuing inspection to maintain proper sanitary and other standards.

Any permit so issued would provide for investigation of all these factors and any permit should be revocable for failure to live up to its conditions. It is believed there will be no greater booster for the proper protection of public water supplies than those who by their interest in recreational facilities have already recognized public health in all its aspects as an asset to be protected and conserved for public benefit.

Regulation of Recreation on Watersheds and Reservoirs

By Russell Van Nest Black

Estimated to have less than a third of needed outdoor recreational facilities, probably no area of comparable size and population density in the country has greater present and potential demand for extended recreational outlets than does the North-Jersey metropolitan district. Because of the high-average density and the resulting high cost of land, only a small part of the needed parks and playgrounds can perhaps be supplied within the metropolitan area itself. The people must go to the forests, streams and lakes of the back country for much of their recreational opportunity just as they have been forced back into these same areas for potable water.

Water is the heart of outdoor recreation, especially in areas beyond urban limits. Streams and lakes are focal points. Water is the outdoor recreational magnet and from it the great majority of outdoor recreation seekers gain by far their greatest benefit and enjoyment.

People must play, but, also, they must have good and safe water to drink. Both recreational and potable water supply uses of water require water reasonably free from pollution. Both recreational and potable water demands upon the streams and watersheds of the state are increasing. If either use insists upon prior and exclusive right to the stream or streams to which it becomes attached, obviously the water resources of the state must fall far short of meeting the dual demand. One use or the other must suffer severely.

Every profession and every private and public interest develops its purists—people who can or will tolerate no compromise with their particular ideals and objectives, people who will not voluntarily bend an inch in recognition of the parallel and perhaps equally important objectives of other people and other interests.

Foresters may say they want no picnickers or hunters or fishermen in their forest-management areas—such people drop matches and burn up the woods. Park and recreation people may insist that streams or lakes not be used for water supply purposes. Reservoirs destroy scenic values and wild life areas. Drawdown exposes mud flats, strands boat docks, and ruins fish-spawning beds. Water

supply people may insist that no man shall step upon and no bird shall fly over a watershed serving as a source of potable water.

Where there are few people, much land, and innumerable streams, the purists can have their way without inflicting hardship on anybody, but not in New Jersey. There is enough waste land in the State for all manner of public uses, but much of it is skim-milk so far as recreational use is concerned. The supply of unspoiled cream, represented by the valleys of clean streams and by lakes and lake borders, is extremely limited. One interest or another must suffer unless some improved working relationship is developed between the recreation and the water supply people.

It is the hope of a good many groups in the state, including the State Planning Board, that there may soon be developed and put in motion an extensive multiple-purpose land purchase program—a program to put to better use at least a part of the State's two million acres of land now being wasted. Among the uses intended to be served are those of watershed protection, a wide range of outdoor recreation and timber growing. Some areas or parts of areas may be of such character and so situated that they should be developed and used primarily for recreation and in other cases, public water supply considerations may take precedence. In only a few instances should it be necessary to develop one use to the exclusion of all others.

It is anticipated that, by necessity and tradition, demand for the highest degree of seclusion from other uses, will come from the public water supply interests. To timber production on public watershed areas there can of course be little objection. Chief protest as in times past, will be against sharing watershed protection areas around storage reservoirs with the recreationists. And yet it is difficult for a thinking citizen to understand how uses such as boating, fishing, hiking, riding, and picnicking on and about long-period storage reservoirs, when permitted at well chosen spots, well regulated, can be of any real menace to a public water supply, when water must in any event subsequently be treated to ensure its safety.

To summarize, the family of public interests in New Jersey is too large, too crowded, and too mutually inter-dependent for any one member, even public water supply, the elder son, to go far on his own without reasonable consideration for the rights and needs of all others. The people of New Jersey are entitled to good drinking water but the need for recreational outlets, while different, is prob-

ably just as great. To the extent that public improvements and public expenditures can be made to serve multiple purposes including those of recreation and public water supply, accomplishment will be that much easier. The situation calls for some concessions by, and much coöperation among, all interests concerned.

Regulation by the State Water Policy Commission

By H. T. Critchlow

The State Water Policy Commission's conception of its duties and powers with relation to the sanitary aspects of artificial lakes has been radically changed by a decision of the Court of Errors & Appeals of the State of New Jersey dated March 25, 1937.

The Commission's specific authority over the construction and maintenance of dams on non-tidal waters within the State is derived from Title 58, Chapter 4 of the Revised Statutes, which continues the Dam Act, Chapter 243, Laws of 1912, as amended by Chapter 107, Laws of 1913 and Chapter 44, Laws of 1919, as well as Chapter 39, Laws of 1928. The 1912 Act reads in parts as follows: "58:4-1. No municipality, corporation or person shall, without the consent of the State Water Policy Commission, hereinafter in this chapter designated as the 'commission,' build any reservoir or construct any dam on any river or stream in this state or between this and any other state which will raise the waters of such river or stream more than five feet above their usual mean low-water height, nor repair, alter or improve existing dams which so raise the water, without such consent, but this chapter shall not affect or relate to dams where the drainage area above the same is less than one-half square mile in extent.

"Where the water surface created by any such dam or reservoir is less than one hundred acres in extent, it shall not be necessary to obtain the approval of the commission for the repair of any such dam which would raise the water less than eight feet above the surface of the ground unless complaint be made in writing to the Commission raising a question as to the security and safety of the existing structure."

Under the Act of 1929, Revised Statutes 48:1-1,creating the State Water Policy Commission, however, the commission is given broad powers to conserve, protect, control and regulate the use, development and diversion of surface, subsurface and percolating waters

of the State and to control and regulate the construction and maintenance of dams.

Prior to 1929 this authority was vested in the Department of Conservation and Development and since July, 1929, has been vested in the State Water Policy Commission. Both of these agencies interpreted the Act of 1912 to apply to the stability and safety of dam structures only. They read into the Act no implication as to sanitary aspects of such construction, believing that these matters were within the jurisdiction of the State Department of Health.

In May, 1935, the Commission approved the application of a property owner situated on the upper reaches of the Rockaway River, for the construction of a dam to create a lake which was to be used as a swimming pool. The permit issued by the Commission carried a special condition requiring among other things that no privy should be constructed or maintained within 100 feet of the shore line of the lake and that the construction and operation of privies on other parts of the property should be satisfactory to the State Water Policy Commission and to the State Department of Health.

The city of Jersey City, which obtains its potable water supply from the Rockaway river at a point some 23 miles downstream from the proposed lake, obtained a writ of *certiorari* against the Commission and the owner. The State Supreme Court upheld the permit and appeal was taken to the Court of Errors and Appeals by Jersey City.

On March 25, 1937, the decision of the Court of Errors and Appeals, prepared by Mr. Justice J. Heher, was filed, reading in part as follows:

"It is evident that the State Water Policy Commission labored under a misapprehension of the nature and extent of its statutory power in relation to the subject matter of the proceedings under review. . . .

"Thus it is that the commission was controlled in the instant case by a limitation of power not found in the statute. While it imposed certain conditions, 'to the end [quoting the language of the permit] that the possibility of pollution of potable waters may be *minimized*,' it may well be that if it were conscious of the full sweep of its statutory power, it would have denied the application altogether. Contamination endangering the public health (such as is beyond the capacity of the natural purifying process contained in

the water itself), even though reduced to a 'minimum,' is not justifiable in the service of a purely private interest. It is to be observed here that appellant adduced expert evidence tending to show the resultants of the contemplated physicial changes would in a very real sense menace the public health, and that the testimony in contradiction introduced by respondents was found to have come from an unqualified witness. We are therefore required to remit the record for a rehearing and a determination of this issue in accordance with the correct principle."

As a result of this opinion of the Court of Errors and Appeals the matter was reheard by the State Water Policy Commission and the issue of a permit was denied.

It is obvious that in the decision just quoted the Court referred to the 1929 Act defining the general powers of the Commission, rather than to the Dam Act of 1912.

In December, 1937, the Commission approved the application of a property owner on a branch of the Rockaway River immediately above the reservoir impounding the public potable supply of the town of Boonton. In this case the permit carried special conditions as follows:

"1. Neither bathing nor swimming shall be permitted in the water impounded by the dam herein authorized.

"2. No privy or other receptacle for human excrement shall be located within one hundred (100) feet of the nearest portion of the impounded water, and any privy or other receptacle for human excrement now existing or hereafter constructed beyond said distance of one hundred (100) feet from the impounded water shall be constructed and maintained at all times in a manner satisfactory to the Commission and to the State Department of Health and so as to prevent extraneous matter from flowing over or upon the surface of the ground. Such excremental matter shall not be allowed or permitted to remain on the surface of the ground nor to be buried or otherwise disposed of within such one hundred (100) foot area of said impounded water, nor shall it be deposited in any place from which it may gain access to the said water.

"3. Subject to the approval of the State Water Policy Commission and the State Department of Health as to location, adequacy, maintenance and operation thereof, the applicant shall provide chlorination facilities at or below the outlet of the water to be impounded by the dam before the construction of the dam is begun

and shall also provide and maintain toilet facilities, coffer dams, sluiceways for handling the flow of the stream, and other facilities necessary for construction of the dam in such a way as to safeguard the water supply entering the reservoir of the Town of Boonton.

"4. In the construction of the dam there shall be a provision for letting down the impounded water into the reservoir of the Town of Boonton, when required by the State Water Policy Commission in an emergency resulting from exceptionally dry weather.

"5. The applicant shall retain a marginal strip of land at least twenty-five (25) feet wide, and above high water mark, completely surrounding the said impounded water.

"6. Every deed, grant, lease or other instrument executed by the applicant pertaining to any property owned by it and forming the basis for the use of the said water shall have the foregoing conditions legibly printed therein with the requirement that the same shall be strictly observed by the person or other parties thereto, and all restrictions set forth herein shall be made a covenant running with the land."

The Town of Boonton obtained a writ of *certiorari* and the State Supreme Court, after a lengthy review of the testimony before the Commission together with additional testimony given at hearings held by the Court, ruled that the permit was proper and this opinion was upheld by the Court of Errors and Appeals in a decision written by Mr. Justice Bodine and filed September 22, 1939.

It appears therefore that in the view of the courts it is the duty of the State Water Policy Commission to consider the sanitary implications of applications for approval of plans for dams which may be submitted to the Commission. It should be noted, however, that the Commission's jurisdiction in sanitary matters extends only to those cases which are properly before the Commission under the provisions of the Dam Act, that is, applications for approval of plans for new dams where the tributary area is greater than one-half square mile in extent and where the water level in the stream will be raised more than 5 ft.; or to applications for the approval of repairs to existing dams where the water level is raised more than 8 ft., provided, of course, that the tributary drainage area is greater than one-half square mile.

It is evident from the six special conditions attached to the second permit mentioned and quoted above, that the State Water Policy Commission is attempting to place safeguards in its permits

for dam construction sufficient to protect the sanitary quality of the water discharged from the lakes and at the same time to provide for a reasonable development of the watersheds of the streams.

Value of Public Park Systems to Rahway Watershed

By Mortimer M. Gibbons

The widespread use of the automobile and the increased leisure of the average man in the past twenty years, have accentuated the problem of recreational uses on potable watersheds. The limited supply of open areas, adjacent to watercourses and readily accessible to our metropolitan centers, and the public demand for parks, have produced pressure in such districts to permit public recreational use of lands on potable watersheds. The sanitary problem involved is, in reality, one of adequacy of supervision and control of recreational uses on watershed areas rather than the adoption of a policy of exclusion of such uses. Without complete watershed ownership, exclusion of recreational activities appears untenable in New Jersey. This may appear to be an unwise lowering of the bars. It can only be justified from a sanitary viewpoint when the area is patrolled and when purification at the water plant is adequate to preserve the safety of the water supply.

The water supply of the City of Rahway, New Jersey, offers a working example of the value of public park systems on a potable watershed, in providing recreational facilities and assisting in the sanitary supervision of such areas. The supply is taken from the Rahway River which drains a well populated valley, about 40 sq.mi. in area, with some manufacturing of a diversified character. Although the city itself owns no land above the water plant, the bulk of the marginal land along the streams, is owned by county park systems, municipalities and golf clubs. Between the most widely used recreational areas and the water plant, there is a nominal storage period of 3 to 4 days in shallow ponds during low stream flow and of only a few hours following a heavy runoff. Purification at the water plant consists of rapid sand filtration, supplemented by aeration, activated carbon, chloramine treatment of the filtered water and pre-chlorination if needed. The purified water readily meets the Treasury Standard.

The establishment of public park areas under the control of duly

constituted park bodies affords an opportunity for cooperative meeting of the water supply needs and recreational needs. The aims and purposes of the two are based on adequate public health protection and any minor differences can readily be adjusted by the cooperative method.

Recreation in the public parks is controlled by the regulations of the various public bodies. Boating, fishing, picnicking and skating are freely permitted. Swimming is restricted to outdoor natural pools where chlorination equipment has been installed. Sanitary facilities are conveniently located. The parks are patrolled by uniformed guards who enforce the regulations.

Sewage disposal in the parks varies, of course, with the location and character of the soil. In isolated places close to the stream, chemical toilets which are cleaned regularly have been used. Usually, septic tanks with tile fields are installed in the larger parks where sewer connections are not available. The sewage disposal system must be designed with a very large factor of safety because of the tremendous fluctuation in load. The attendance varies with the weather, holidays, and special attractions. The most popular park in the watershed had an average daily attendance of about 1,000 with a peak day of 20,000. The area is only 0.2 sq.mi., so the temporary density of sewage contributing population was 100,000 per sq.mi., lasting only a few hours. The necessity for careful design and operation of sewage disposal systems in public parks seems to be the most important angle of the recreational problem from the viewpoint of the water supply concerned.

In the elimination of industrial pollution of the water supply, the presence of public parks on the watershed has been beneficial. Two former factory sites containing chemical waste lagoons, have been purchased, filled and converted into playgrounds definitely eliminating sources of objectionable taste and odor in the water supply. Several instances of the killing of fish or the abnormal appearance of odor have been reported promptly and in cooperation with the water officials early abatement of industrial contamination results.

A possible conflict of interest of public parks and water supply may arise in the character of the development of water sites. The aesthetic eye of the landscape architect may be offended by the exposed banks of a deep pond when the water is drawn down. Shallow ponds designed for flood control and natural beauty are cheaper

to construct and equally pleasing to the eye, yet they present an ideal environment for luxuriant algal and weed growth. Control of the vegetation growth is difficult because a boat cannot be used in portions of the ponds and costly hand spraying may be necessary. Moreover, there is an increased cost for purifying the algal-laden water at the treatment plant, illustrating a disadvantage of public park development. Yet the safety of the water supply is not adversely affected.

What sort of purification is "adequate" to insure the safety of a surface water supply when portions of a watershed are used for recreational purposes? In the writer's opinion, purification measures should include both filtration and disinfection. Storage with disinfection may be sufficient when the entire watershed is owned by the water supply, for in such cases recreational use can be closely limited. But public park development along streams in potable watersheds, adjacent to cities, will bring a large transient population even to sparsely populated or distant areas. For this reason, filtration of public water supplies appears to be a necessary measure of protection incidental to general recreational use of a potable watershed.

Effect of Multiple Use of Watershed on Conservation

By C. P. Wilber

The relationship between management as water supplies and use for public recreation of areas set aside as potable watersheds must be decided primarily upon the question of safety to the water supply involved. This phase of the question is one on which the author is not qualified to speak. Wherever recreational use of such an area is possible, without incurring real danger to the purity of the water, the question would seem to be one of the relative value of the recreation use compared with the cost of providing sufficient safeguards against dangerous pollution of the water or with the cost of purifying the water to the safety point to remedy the pollution due to recreational use.

There are of course multitudes of examples of water polluted far beyond any danger point which reasonable recreation use would create. Such water is remedied by physical and chemical treatment in the lower stream, subsequent to the pollution, to make it usable

for domestic purposes. One outstanding example of this in the Jersey territory is the Delaware River itself. Therefore, it seems that, provided the cost involved is justified, it is possible to purify water from streams and ponds where necessary, thereby to protect subsequent users.

It is very generally recognized that the maximum efficiency of a watershed both as regards the volume and quality of the water produced is found on a completely forested area. It will not be questioned either that a forest cover is the best protection against turbidity in the outflow from a catchment area in times of flood and against the silting of streams and water supply reservoirs as a result of erosion. The forest cover can and should have a commercial value for timber crops under proper protection and management. Therefore, any potable watershed, largely held in public ownership, apparently should most wisely be kept in forest cover for its protection and, as a matter of economy should be so handled that, as soon as possible, it will produce returns from the crop which the land can produce.

The money return from timber crops within the New Jersey area is recognized as a modest one. Also because of past abuse and present condition, the time when any appreciable profit can be secured from most of the woodlands is a long way off. The holding by the public of large areas for watersheds alone, therefore, will be an expensive program, no matter how necessary, if water is the only immediate benefit to be anticipated.

New Jersey with its density of population (nearly 600 people per sq.mi.—the densest population in the Union with the exception of Rhode Island), however, needs a large area of public reservations for outdoor recreation. At the present time the State has approximately 20 acres of such reservations per thousand inhabitants including all municipal, county and state lands, whereas Pennsylvania has nearly 175 acres, and New York nearly 250 acres per thousand. New Jersey, therefore, is not only inadequately provided with outdoor recreational areas but is shamefully behind her neighboring states, including not only New York and Pennsylvania, but other states, comparable with her in population, wealth and leadership.

In addition to its own population, New Jersey is the hub of the greatest concentration of population in the western hemisphere, if not in the world. It has an opportunity, in serving this tremendous population with outdoor recreational facilities, to build up and

maintain an economic asset, the value of which would run into many millions of dollars annually, in addition to taking care of the social needs of her own population.

It would seem from this that the possibility of combining recreational use, timber production and potable water production deserves the most careful study and that so far as possible these three uses of any given area should all enter into a well balanced land-use program.

The intensity of recreation use is a matter which can and should be regulated on any area designated for such multiple use. It must be determined by the relative value of the various uses and the justifiable cost of protecting the water against other public use. The type of recreational use should be subject to similar control, with a possibility, where necessary, of complete prohibition against certain forms of recreation. For instance, bathing would undoubtedly be impossible at certain places. The possibility of the public use for water production may in frequent instances justify the cost of public acquisition of the land where some question might enter in if public ownership were to involve only timber production or timber crops and public recreation. It follows that any adequate and well balanced land-use program for the state should properly consider the vast potable water needs of the state as one of the items making public ownership essential in many instances and as one of the factors making public ownership justifiable in other areas. The author is tempted to believe that there will be many instances in which the combined value of the water output, timber crop and recreation service which an area can render the public will outweigh any other values which the land can promise in any form of private ownership under the best conceivable conditions. He feels equally satisfied that there are many situations in which it will be difficult to justify public ownership. The state faces a water problem, a serious outdoor recreation situation, and an appalling waste land condition. It seems that not only good policy, but good sense, dictates a common sound coöperative approach to these problems, by those responsible for woods, water, wild life and recreation.

EDITOR'S NOTE: See page 1044 of this JOURNAL for an abstract on "Report Relative to the Propriety of Opening Lake San Leandro [California] to Public Fishing" by Charles Gilman Hyde for the San Leandro Chamber of Commerce.

Break-Point Chlorination at Anderson

By P. C. Laux

ANDERSON obtains its water supply from the west fork of White River. At times the Muncie (population—55,000) sewage flow is nearly half the flow of the stream from where it enters the river about 25 miles above the Anderson intake. During hot weather the Anderson municipal light plant uses the total river flow three times per day for condenser cooling. This high temperature water enters the river above a small dam and the resulting algal growth at the intake is very heavy. When the river is low and the weather cold the natural purification processes are so retarded that again there is a real purification problem.

In solving the problem, carbon must be used sparingly because poor filter construction permits the fine particles to pass the filters and enter the clear well and when hot water boilers and tanks are used extensively in the winter this is a constant source of complaint. Even coarse grind carbon does not eliminate the condition, so it is a matter of choosing between complaints against the taste of the water or against the carbon in the hot water tanks.

While carbon controls taste pretty well when added in sufficient quantities, records show that with ordinary pre-chlorine doses most lactose broth tubes usually show the presence of gas forming bacteria. At no time are they entirely absent. Since most positive tubes do not confirm and since the quality of water is well within the prescribed standards, this may have but little or no sanitary significance. It was the desire to eliminate this condition, however, that led to an attempt at super-chlorination and to its subsequent development.

In 1932 it was the practice to add ammonium sulfate to the suction well and chlorine to the low duty pump suction. Ammonia was

A paper presented on April 4, 1940, at the Indiana Section Meeting, Lafayette, Ind. by P. C. Laux, City Chemist, Water Department, Anderson, Ind.

added through a solution pot to which a pound of ammonium sulfate was added every hour. A 60-pound chlorine machine furnished its maximum capacity at all times. Addition was made on the theory that the ammonia would hold down the chlorine taste. Actually the method was impractical because it retarded the sterilizing action of the chlorine. When the ammonia treatment was discontinued, some improvement in bacterial quality was noted, but most lactose broth tubes were still showing gas formation after 48 hours.

The next treatment attempted involved increasing the capacity of the chlorine machine to 80 lb. and changing one of the post-chlorine

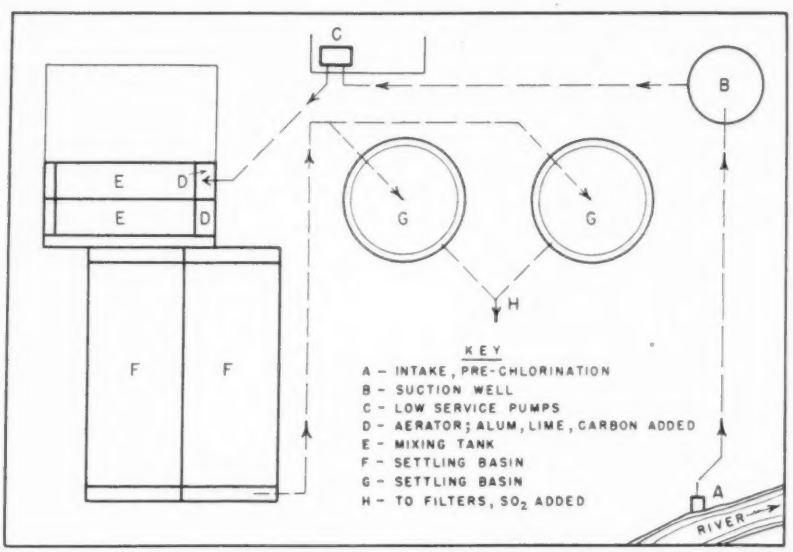

FIG. 1. Diagrammatic Layout of Anderson Filter Plant

machines to pre-chlorination. Enough chlorine could now be added to reduce further the number of lactose broth tubes showing gas and to eliminate practically all positive confirmatory tests. The method produced a vile tasting water and it was found necessary to control pre-chlorination to the point where only a trace of chlorine remained in the filter influent. In this manner much more chlorine could be added and the residual chlorine reduced to the desired point before the water flowed to the filters. The settled water carried a residual of about 0.75 p.p.m., reduced to 0.10 p.p.m. by the addition of sulfur dioxide gas. This treatment bettered the bacterial condition of the water but did not materially affect the taste. Figure 1 shows a lay-

out of the plant with a key to the various points of chemical application up to the filters.

Laboratory experiments in 1935 showed a zone of chlorination where additional chlorine decreased rather than increased the residual chlorine in the water. Since this was a new phenomenon, many chlorine tests were run over a period of several months. The break-point always appeared, but the dosage at which it appeared constantly changed; sometimes the change was slight but at other times the variation was unbelievably large. This discovery led to the belief that what had been supposed to be super-chlorination, with de-

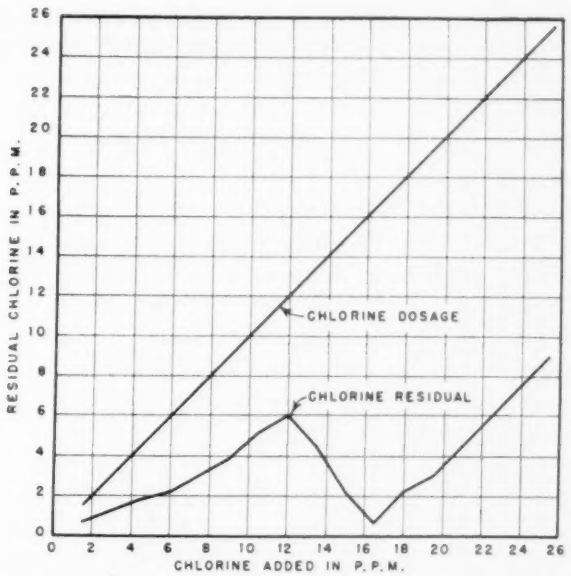

FIG. 2. Ortho-tolidine Color Development in Break-Point Chlorination

chlorination before filtration, was not even adequate chlorination. Adequate chlorination was taken to mean chlorination to the break-point in the chlorine residual. Figure 2 is a curve plotted to show chlorine residuals at various chlorine dosages; it points out very clearly the break-point in the process.

Laboratory tests showed water so treated to be practically free from bacteria-forming gas in lactose broth, and led to the belief that taste control was also possible with the method. Intermittent attempts were made to put it into practice and frequently plant runs were obtained that gave satisfactory results for a period of weeks at a

time. These periods were proof of the fact that the treatment would produce an improved bacterial quality and that a water so treated was decidedly improved in taste.

New Test Used

One thing, however, was lacking. To use break-point chlorination with success required some method of determining promptly and accurately whether too little or too much chlorine was being added. First in the attempt to work out such a method was the determination of the chlorine demand of the river water. This was done by standardizing chlorine water from the solution hose of a chlorinator to 100 p.p.m., and treating 100 ml. samples of river water with varying dosages of chlorine water. One ml. of the solution to 100 ml. of water equalled 1 p.p.m. Erlenmeyer flasks were used, and the chlorine solution was standardized for each test run. Samples were rotated while the solution was added, kept in agitation for 5 min. and allowed to stand for 2 hr. Then 5 ml. of ortho-tolidine were added to each sample. Color was allowed to develop for 10 min. With chlorine demands doubling sometimes from day to day and varying as much as 5 to 6 p.p.m. within several hours during the winter, the method was entirely too slow and cumbersome. Also it was inaccurate because over-sized orifice meters were used in the chlorine machines and the amount of chlorine actually used did not equal the meter reading. Added difficulty was encountered because the raw water meter was inaccurate.

The next attempt was a trial of the zonite method on the water entering the mixing tank. Zonite was used so the operators could have a reasonably standard solution at their disposal during the night shift. One ml. of zonite was diluted to 100 ml. with tap water. Seven samples were set up. The first sample was the blank and 1, 2, 3, 4, 5 and 6 ml. of zonite solution were added to the six samples as previously described. After a half hour ortho-tolidine was added to the blank and the treated samples, and color allowed to develop as before. If the color development was increasingly strong in each succeeding sample, it was assumed that the treatment was on the high side of break-point chlorination; if any samples beyond the blank showed a lower color development than the blank it was assumed that more chlorine was needed to reach the break-point. This method was simple, but it had two disadvantages. The operators and chemists are human and therefore loathe to throw away an old

solution and make a new one, and the time required was still too long. Sometimes the river water changed beyond the break-point shown by a test, before the results of that test could be put into application.

Though these two methods were unsatisfactory, they did serve a useful purpose. Many such tests were run daily for months and it finally became apparent that the ortho-tolidine color development reaches its maximum reading much more slowly when the dosage is below break-point chlorination than when it is above. From this observation was developed the flash reading method.

This method consists of taking a flash or 10-second reading and watching the color development by minutes. If there is little difference between the flash reading and the 1-minute reading, and the

TABLE 1

Color Development of Ortho-tolidine in Residual Chlorine Readings, Near Break-Point Chlorination

CHLORINE ADDED	RESIDUAL CHLORINE READINGS IN P.P.M. AFTER					
	10 sec.	1 min.	2 min.	3 min.	4 min.	5 min.
p.p.m.						
6.0	.05	.20	.35	.45	.50	.75
6.5	.00	.05	.10	.10	.10	.10
7.0	.00	.05	.05	.05	.10	.10
7.5	.05	.05	.10	.10	.10	.10
8.0	.15	.15	.15	.20	.25	.25

color development by minutes is slow, then break-point chlorination has been reached or exceeded. If, however, there is a big jump from the flash reading to the one minute reading, then break-point chlorination has not been reached.

Flash Reading

Table 1 shows ortho-tolidine residual chlorine readings by minutes for dosages just above and below the break-point. The figures are the results of laboratory tests, not of plant operation. Table 2 shows the same results on another day through the entire range of chlorine dosages to just beyond the break-point, dosage increases being 0.5 p.p.m. Figure 3 shows curves drawn from 10-second, 1-minute and 5-minute readings given in Table 2. The plant application of this test at Anderson as follows:

Samples are collected from the end of the mixing tank every 2 hr. and allowed to stand for 30 min. at room temperature. The sample is then measured into a comparator tube and ortho-tolidine is added. A flash, or 10-second reading, a 1-minute and a 5-minute reading are taken. If the ortho-tolidine color is strong at once and the 5-minute reading is between 0.40 and 0.75 p.p.m. the water is considered satisfactory. If the color comes in strong at once and the 5-minute reading goes over 0.75 p.p.m., the chlorine dosage is reduced. The amount of reduction, of course, depends on the final reading.

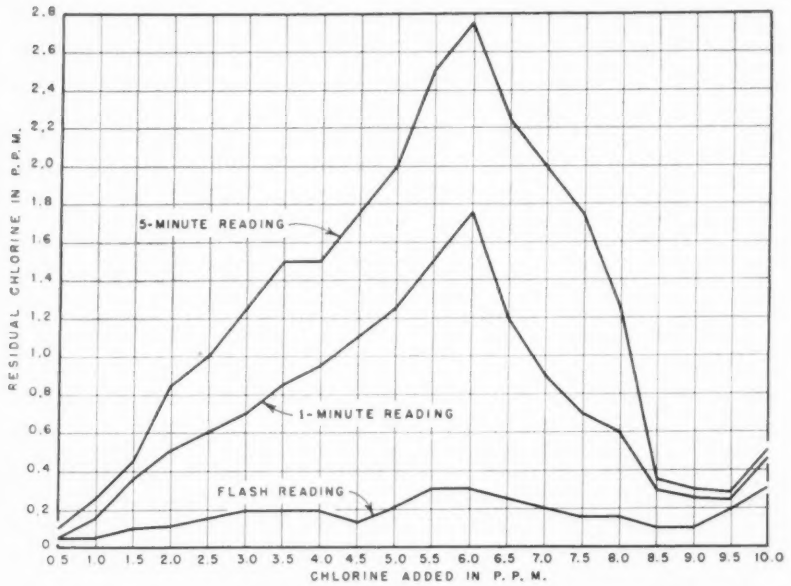

FIG. 3. Chlorine Residuals, after 2-hour contact at freezing point January 4, 1940

If the final reading is below 0.40 p.p.m. the chlorine dosage is increased. Likewise, if the original color development is low, the dosage is increased, and the higher the 5-minute reading, the greater the increase in the chlorine dosage.

Twenty minutes after a change has been made a sample is taken from the low duty pump. This sample is allowed to stand for 30 min. and then tested with ortho-tolidine. Ten-second, 1-minute and 5-minute readings are taken. If there is little variation between these readings and the 5-minute reading is not over 1 p.p.m., then the

dosage is considered satisfactory. If color development is slow, or if the final residual reading is below 0.75 p.p.m., more chlorine is added. If the color development is fast and the final reading is over 1 p.p.m. the chlorine dosage is reduced. This routine is repeated until the proper dosage has been attained. Time can be saved by making a reading on the pump sample immediately after it has been collected. If the immediate color development is sluggish, the rate of chlorine feed is raised immediately. If it is high, it is safer to base the chlorine feed rate on the reading after the sample has stood for 30 min.

TABLE 2

Color Development of Ortho-tolidine in Residual Chlorine Readings, up to Break-Point Chlorination

Cl_2 ADDED	RESIDUAL Cl_2 READINGS			Cl_2 ADDED	RESIDUAL Cl_2 READINGS		
	10 sec.	1 min.	5 min.		10 sec.	1 min.	5 min.
p.p.m.				*p.p.m.*			
0.5	.05	.05	.10	5.5	.30	1.50	2.50
1.0	.05	.15	.25	6.0	.30	1.75	2.75
1.5	.10	.35	.45	6.5	.25	1.20	2.25
2.0	.10	.50	.85	7.0	.20	.90	2.00
2.5	.15	.60	1.00	7.5	.15	.70	1.75
3.0	.18	.65	1.25	8.0	.15	.60	1.25
3.5	.20	.85	1.50	8.5	.10	.30	.35
4.0	.18	1.00	1.50	9.0	.10	.25	.30
4.5	.12	1.00	1.75	9.5	.18	.25	.25
5.0	.18	1.25	2.00	10.0	.30	.45	.50

At the present time the results of the pump sample readings and the mixing tank samples are being correlated in an effort to base plant control entirely on hourly pump sample readings. This would provide a much closer check on plant control. At the same time data are being gathered on what might be called the color development test. The sample is watched carefully as the ortho-tolidine is added. It seems that an instantaneous color indicates break-point chlorination has been reached or exceeded. If it takes two or three seconds for the color to become apparent, the rate of application has not reached the break point. Sufficient data on this test are lacking. Table 3 illustrates a test run for this purpose. Samples were collected from the low duty pump, from the head of the mixing tank (after aeration) and from the end of the mixing tank.

These samples were collected after no change had been made in the chlorine dosage for 3 hr. No change was made for 2 hr. after the collection of the sample. Other tests have been run where the differences were considerably greater, while in some cases the variation was quite low. The instance cited, however, is the most typical and indicates that pump samples can be used for plant control by the simple expedient of carrying higher residuals there than are carried at the outlet of the mixing tank.

Successful application of this test enables one to overcome the difficulties of sudden river changes. As an illustration can be cited the changes in chlorine feed rate at Anderson on March 24. At 7:30 A.M. the rate was changed from 250 lb. to 300 lb. per day; at 8:00 A.M., to 320 lb.; at 9:15 A.M., to 340 lb.; at 3:00 P.M., to 300 lb., and

TABLE 3

Residual Chlorine Readings of Samples Collected at Various Points After Various Standing Times

STANDING TIME	LOW SERVICE PUMP RESIDUAL Cl_2 AFTER			INLET OF MIXING TANK RESIDUAL Cl_2 AFTER			OUTLET OF MIXING TANK RESIDUAL Cl_2 AFTER		
	10 sec.	1 min.	5 min.	10 sec.	1 min.	5 min.	10 sec.	1 min.	5 min.
None	1.00	1.25	1.50	0.80	0.90	1.00	.70	.80	.90
10 min.	0.75	0.80	1.10	0.80	0.80	0.90	.65	.70	.85
20 min.	0.75	0.80	1.00	0.60	0.60	0.75	.45	.45	.65
30 min.	0.60	0.70	0.90	0.45	0.50	0.60	.45	.45	.60

at 5:15 P.M., to 260 lb. By changing promptly as the results of tests showed changes in the river, both over-chlorination and under-chlorination were avoided in spite of the fact that the chlorine demand of the raw water varied between 65 and 85 lb. per million gallons within twenty-four hours. Frequent sampling, and patience in waiting for the proper time to collect and read samples, are essential to the success of this method.

Successful break-point chlorination as practiced at Anderson requires some means of de-chlorination. This is accomplished as before by adding sulfur dioxide gas through a chlorinator to the settled water just as it passes to the filters. Readings are taken on composite samples from the filter surfaces hourly. A trace of chlorine is left in the water as otherwise it might be possible to add excessive sulfur dioxide doses unknowingly.

Such over-treatment, of course, would be discovered by a drop in the next succeeding reading after post-chlorination, and therefore would not be very serious. Experience has shown that over 0.15 p.p.m. of residual chlorine on the filters is apt to develop a taste in the filter effluent. Therefore sulfur dioxide dosages are regulated to carry a residual chlorine on the filter surfaces not under 0.05 p.p.m. and not over 0.10 p.p.m. Post-chlorination is used to carry a final residual between 0.25 and 0.35 p.p.m. in the finished water. A residual of 0.40 p.p.m. or over is apt to develop an after-taste.

Another requisite for proper break-point chlorination is ample chlorination equipment. During the past summer little difficulty was experienced in water treatment until late in August. Then the rains stopped and by mid-September the 400 lb. of chlorine per day that could be fed was inadequate, in spite of very high carbon feeds. After some wishful waiting, a 385 lb. chlorine tube was procured for one of the machines; and later another for the second machine. By this expedient it was possible to feed over 600 lb. per day with 400-pound equipment. Heavy carbon dosages were necessary to approach the break-point. When the river froze over even this was inadequate and an emergency 300-pound chlorinator was borrowed, and for a week or ten days all was well. When the chlorine demand on the river water went to 35 p.p.m., in spite of a carbon dose of 12 p.p.m., it was found necessary to revert to the old method of so-called super-chlorination. All attempts at break-point chlorination were abandoned until the ice left the river.

The severe cold weather made it necessary to operate the plant at a 6 m.g.d. rate, instead of the usual 4 m.g.d. This, together with the extremely high chlorine demand of the river water made it impossible to reach break-point chlorination. At present it is hoped that the chlorination capacity of the plant will at least be doubled. It would be better to triple it, for, it is under emergency conditions that break-point chlorination is really needed.

When ordinary pre-chlorination was used, chlorine was purchased in less than carload lots at $7\frac{1}{2}$ cents per lb. When super-chlorination was started, purchases were made in carload lots at $5\frac{1}{2}$ cents per lb. Provisions are now being made to handle ton containers, the price of which will be $2\frac{1}{4}$ cents per lb. Since sulfur dioxide is more expensive than chlorine, and since its use is much greater with so-called super-chlorination than with break-point chlorination it is foolish not to go

all the way with chlorine treatment. Then, too, with heavy sulfur dioxide dosages, more lime is required to reach the proper pH value, and if, as seems possible, high-priced carbon consumption can be held to a minimum, a further saving will be effected.

March, 1940 was the first month during which the flash reading method of determining chlorine dosages was attempted. It was also the first month in which it has been possible to remain within reasonable range of break-point chlorination for an entire month. In view

TABLE 4

Summary of March, 1940, Chlorine Residuals at Various Sampling Points

MIXED WATER		SETTLED WATER		DECHLORINATED WATER	
p.p.m.	% time	p.p.m.	% time	p.p.m.	% time
0.00–0.25	10	0.00–0.15	26	0.05	52
0.26–0.50	40	0.16–0.25	39	0.10	20
0.51–0.75	26	0.26–0.35	11	0.15	18
0.76–1.00	24	0.36–0.50	21	Over .15	10

TABLE 5

Operating Data for March, 1940

	PUMPAGE	CHLORINE USED			CHLORINE RESIDUAL	
					Mixed	Settled
	m.g.d.	*lb./day*	*lb./mil. gal.*	*p.p.m.*		
Average	3.6	285	79	9.5	.60	.27
Maximum	4.7	388	110	14.0	1.00	1.00
Minimum	2.7	214	49	6.0	.12	.05

Pumpage for month of March: 111.2 mil. gal.
Chlorine used in month of March: 8,826 lb.

of the fact that four operators had to be trained within a week as to the meaning and application of the test, considerable pride is felt in the achievement. Tables 4 and 5 were compiled from the operating data for the month of March and are here presented as proof of the feasibility of the test.

The maximum and minimum figures for showing the chlorine demand are really the averages for the highest demand day and the lowest demand day. Actually during the month the chlorine demand varied between 17.5 p.p.m. and 5 p.p.m.

It has been concluded that:

1. Apparently break-point chlorination dosages can be controlled by observing the speed with which ortho-tolidine color develops in the test tube.

2. Experiences at Anderson indicate that taste can decidedly be controlled or entirely eliminated.

3. Break-point chlorination reduces to a minimum the number of lactose broth tubes that show gas formation after 48 hours' incubation.

4. Sufficient chlorination equipment must be at hand to meet all river changes that cause abnormal chlorine demand.

5. De-chlorination is essential for proper taste control, especially if carbon is omitted.

6. The large quantities of chlorine used make it possible to buy chlorine at a lower unit price. This fact, together with the fact that higher priced carbon can be used more sparingly, eliminates or minimizes any increase in the cost of treatment.

Determination of Minute Amounts of Phenol In Water Containing Sodium Sulfides

By L. S. Renzoni

DURING the past few years the Port Colborne and Welland domestic water supplies have been contaminated periodically with substances giving rise to a phenolic taste and odor upon chlorination. The experimental station of the Ontario Department of Health established the presence of phenolic substances in the water and set out to determine their source.

From observations over a period of years, it was fairly well established that this contamination of the water at the towns mentioned occurred during or immediately after periods of easterly winds. It was also observed that the Maple Leaf Milling Co. plant which is situated on a point of land jutting out into Lake Erie, on the west bank of the canal, rarely suffered from this type of water contamination. It was, therefore, believed that the source of phenols was a point near the east bank of the canal. From such a point, an east wind might then carry the phenolic water to the mouth of the canal, and then to the Port Colborne and Welland water supplies.

Since the International Nickel Co. refinery effluent flows into Lake Erie at such a point, Mr. Walter, general superintendent of the refinery, called upon the writer to carry out a complete investigation in cooperation with the Department of Health, to determine whether any of the refinery effluents contained phenols in concentrations sufficient to cause the contamination previously mentioned.

Preliminary work showed that although phenol gave no taste to distilled water containing 1000 parts per billion, 10 to 20 parts per billion in chlorinated water was sufficient to give the characteristic taste of the Port Colborne water. From this, it was evident

A paper presented on March 27, 1940, at the Canadian Section Meeting at London, Ontario, by L. S. Renzoni, Research Chemist, International Nickel Company, Port Colborne, Ont.

that the method of analysis used would have to be sufficiently sensitive to detect phenol in these minute concentrations.

A review of the literature* showed that standard methods of analysis were available for the determination of phenol in the amounts indicated. These methods consisted of concentration of the sample to such a degree as to bring the phenol concentration within the range of sensitivity of the reagent used. This was carried out as follows:

The original water sample (usually 2 liters), made alkaline by the addition of sodium hydroxide, was evaporated to a volume of approximately 200 ml.

This concentrate was distilled from a solution acidified by the addition of citric acid. The phenol, which was then concentrated in the distillate, was estimated colorimetrically by the use of one of the following reagents: (1) Folin-Denis or Folin-Ciocalteu (aqueous solution of sodium tungstate, molybdenum trioxide, phosphoric acid). The reagent was sensitive to a phenol concentration of one p.p.m., giving rise to a deep blue color; (2) diazotized sulfanilic acid, sensitive to a phenol concentration of 10 parts per billion phenol, giving a bright yellow color; and (3) Gibbs Reagent, sensitive to 20 parts per billion phenol, giving a deep blue color.

The method of concentration and reagents cited gave the following results when used in the analysis of the nickel refinery effluent (in each case original volume of refinery effluent was 2,000 ml., and final volume, 100 ml.): with the Folin-Denis reagent, a phenol content of 200 p.p.m.; with sulfanilic acid, 400 p.p.m.; and with the Gibbs reagent, an absence of phenol. It was obvious from these results that an interfering substance was present which led to the high results with the Folin-Denis and diazotized sulfanilic acid reagents and the zero result with the Gibbs reagent.

It was known that the nickel refinery effluent contained appreciable quantities of sodium sulfides, Na_2S_x, and that the method of concentration allowed for the presence of the sulfide ion in the final sample. Experiments carried out by the Department of Health, and independently by the writer, showed that the sulfide ion formed a blue color with the Folin-Denis reagent, and a yellow with the diazotized sulfanilic acid, both colors similar to those produced by phenol, and consequently leading to high results. With Gibbs reagent, the sulfide ion produced a red color which disappeared in a few minutes, but the reagent was decomposed, and the blue color

* *Standard Methods of Water Analysis.* American Public Health Association and American Water Works Association, New York, 8th ed., 1936; p. 235.

of the phenol compound did not appear on standing. By adding an excess of Gibbs reagent it was possible to show the presence of phenols qualitatively. Quantitive determinations could not be made because a certain amount of the red color persisted and interfered with the readings.

These results showed that the interference was due to the presence of the sulfide ion and that a modification of *Standard Methods* was necessary to allow for its removal from the sample before the addition of the reagent. This was accomplished by the addition of a freshly prepared cadmium carbonate suspension to the original or partially concentrated sample, and filtering off the precipitated cadmium sulfide.

A more rapid method of sample concentration, based on the infinite solubility of phenol in ether, and its limited solubility in water at 20°C. was also determined. The distribution law states that for dilute solutions, the distribution constant for a given substance between two solvents is the ratio of the solubilities of that substance in the two phases. The distribution constant for phenol between ether and water, therefore, would be

$$\frac{\text{Molal solubility of phenol in ether}}{\text{Molal solubility of phenol in water}} = \text{K}, \quad \text{or} \quad \frac{\text{L}\infty}{0.96} = \text{K (very large)}$$

which shows that extraction of phenol from water at 20°C. should be complete in one operation. This was found to hold true from results of experiments carried out with standard phenol solutions.

The estimation of phenol by means of the reagents mentioned above required that the phenol be in an aqueous solution. Complete recovery of the phenol from the ethereal solution was brought about by extraction with a small volume of normal sodium hydroxide solution. By this operation, the phenol was changed to sodium phenate, insoluble in ether but very soluble in water, and then was concentrated in a small volume of alkaline solution. This solution was free of sulfide, and when neutralized and made up to proper volume, was ready for the addition of the reagent.

During the investigation at the experimental station of the Ontario Department of Health, it was found that Gibbs reagent gave the most consistent results. James Duncan also found that the phenol test could be made more sensitive by the addition of *N*-butyl alcohol to the color tubes after the blue color had fully developed. The butyl alcohol dissolved the colored compound and

concentrated it on the top alcohol layer where it was clearly visible. This made the phenol test sensitive to 5 to 10 parts per billion.

Following is an outline of the procedure which was used in the analysis of the nickel refinery effluents and by which phenol present in water in concentrations as low as one part per billion can be estimated.

Measure one liter of the sample into a 2-liter beaker. Add 2 to 4 grams of solid sodium hydroxide and stir until dissolved. Evaporate slowly on the hot plate to a volume of approximately 400 ml. Add a freshly prepared suspension of cadmium carbonate in small amounts until it no longer turns yellow. Filter into a 1,000 ml. Erlenmeyer flask, cool to 15°C. and acidify with 1:1 HCl, keeping the contents of the flask below 20°C. Extract the phenol from the acidified filtrate with 100 ml. of ethyl ether in a 500 ml. separatory funnel. The extraction should be carried out in four steps using roughly 100 ml. of the sample each time. Discard the water layers. To the ether solution in the separatory funnel, add 50 ml. of normal sodium hydroxide solution and shake well. The water layer will now contain the phenol as sodium phenate. Transfer this solution to a 100 ml. Erlenmeyer flask, and make it slightly acid with 1:1 HCl, again keeping the temperature below 20°C. Dilute to a volume of 100 ml., adjust to pH 9.6 with sodium carbonate or sodium tetraborate solutions and transfer to a 100 ml. Nessler tube. Prepare standard phenol solutions in similar matched 100 ml. Nessler tubes and adjust to pH 9.6. Add to these tubes and to the sample of the unknown, freshly prepared solution of the reagent as described in *Standard Methods*. Stopper the tubes and allow them to stand overnight, or at least for a period of four hours to allow the color to develop. At the end of this period, add 10 ml. of *N*-butyl alcohol to each tube, shake to obtain good mixing and allow the tubes to stand for a few minutes to obtain a good separation of the alcohol. Compare the intensity of the blue color in the alcohol layer of the unknown to that produced by the standard solutions, and from this value, calculate the phenol content of the original sample.

This method of analysis was found to give reliable results when checked with standard solutions.

The nickel refinery's combined effluent analyzed by the method outlined above was found to contain from 5 to 10 parts per billion of phenol, which concentration was too low to cause the contamination of the Port Colborne and Welland water supplies.

Discussion by *Douglas Feben*.* Mr. Renzoni's investigations have resulted in a definite contribution to the determination of phenol in water. His method of securing a concentrate is certainly to be recommended, since combined with its simplicity is the advantage of practically 100 per cent recovery, which is decidedly more accurate than the approximately 76 per cent recovery of the distillation method in the current *Standard Methods*.

During the past two years in Detroit we have been interested in the determination of phenols incidental to some activated carbon research. Casting around for a procedure which would be suitable in the range between the Koppeschaar (excess bromine) method and the Fox and Gage (diazotized sulfanilic acid) method, Mr. Rausch of the Water Works Park staff suggested the Folin-Denis reagent. It appears that this reagent is little known in the field of water purification, for which reason the writer's modification of this method is here given:

Dissolve 100 grams of sodium tungstate, $Na_2WO_4 \cdot 2H_2O$, and 25 grams of sodium molybdate, $Na_2MoO_4 \cdot 2H_2O$, in 700 ml. of water in a 1500 ml. flask connected by ground glass joint to a reflux condenser. Add 50 ml. of syrupy 85 per cent phosphoric acid and 100 ml. of hydrochloric acid. Reflux the mixture gently for ten hours. After this time, cool, add 150 grams lithium sulfate, Li_2SO_4, 50 ml. of water and 4 to 6 drops of liquid bromine. Boil the mixture under a hood without the condenser for 15 min. to boil off excess bromine. Cool, filter and dilute to 1 liter. This stock solution should have a golden yellow color with no greenish tint.

To obtain the Folin-Denis reagent standard solution, dilute 160 ml. of the stock solution to 1 liter.

The sodium carbonate solution is obtained by dissolving 4.48 grams of anhydrous sodium carbonate in 100 ml. of distilled water.

Clean as many 250 ml. beakers and watch glasses as will be required for standards and samples. Mark each beaker with the phenol concentration being prepared as a standard, or the sample designation. To the beakers marked as standards, add the required amount of standard phenol solution and 80 ml. of distilled water.

Into the beakers prepared for samples, add 100 ml. (or an aliquot portion diluted to 100 ml.) of the corresponding samples.

Add 1 ml. of the standard Folin-Denis reagent to each beaker, mix, and let stand for 3 min.

* Senior Sanitary Chemist, Department of Water Supply, Detroit.

Add 1 ml. of the sodium carbonate solution to each beaker, mix, cover with watch glasses and transfer to hot-plate.

Bring all beakers to boiling; boil gently for five minutes and remove.

When beakers and contents have cooled sufficiently for handling, transfer to 100 ml. matched Nessler tubes properly marked.

Wash each beaker with a small amount of distilled water and use the washing from each beaker to bring the corresponding tube up to the mark.

Readings can be made at any time.

It may seem that the preparation of the Folin-Denis reagent is somewhat time consuming, but it has one distinct advantage. Once prepared, it is quite stable and can be used at any time. This is not the case with the indicators used in other methods of phenol determination in which they have to be prepared every time a test is to be made.

We have found the sensitivity of this method to be about 50 parts per billion. The colors produced are fairly stable, but there is a definite color development on standing. However, no appreciable difference has been found in readings made immediately after preparation or after 24 hours standing.

ABSTRACTS OF WATER WORKS LITERATURE

Key. 31: 481 (Mar. '39) indicates volume 31, page 481, issue dated March 1939. If the publication is paged by issues, **31:** 3: 481 (Mar. '39) indicates volume 31, number 3, page 481. Material enclosed in starred brackets, ★[ ]★, is comment or opinion of abstractor. Initials following an abstract indicate reproduction, by permission, from periodicals as follows: *B. H.—Bulletin of Hygiene (British); C. A.—Chemical Abstracts; P. H. E. A. Public Health Engineering Abstracts; W. P. R.—Water Pollution Research (British); I. M.—Institute of Metals (British).*

IMPOUNDING RESERVOIRS

Report Relative to the Propriety of Opening Lake San Leandro to Public Fishing. CHARLES GILMAN HYDE. (Aug. 11, '38). Report deals with propriety of opening lake to public for fishing and recreation. San Leandro Chamber of Commerce and associated sportsmen of Calif. requested such opening. Sportsmen's Club requested hearing before directors of East Bay Municipal Utility District. Hearing was held on June 22, '38. Sportsmen claimed that approx. 400,000 active fishing licenses in Calif., that approx. 50,000 licenses would be prospective fishermen in lake, that income might be as much as $442,500 per annum and that need existed for recreational facilities. Proposed regulations submitted involved fines and/or imprisonment for non-use of toilet facilities, throwing of dead fish, offal, garbage, etc. into water. Dogs, firearms, wading, swimming and camping were to be prohibited and various regulations relating to permits, use of boats, type of bait, policing, etc., were to be made. Lake (3.77 mi. long and 0.16 mi. wide) is too small to confine fishing and recreational activities to points several miles distant, and in this respect it differs from larger reservoirs and lakes where fishing is permitted. Fishing and recreational activities are prohibited on and around res. and tributary streams owned by District. Res. is of sufficient size for prolonged detention of water, if protected from local pollution. From aesthetic and psychological standpoints most satisfactory water supply is from clean, controlled watersheds and res. unpolluted by human wastes. Fishing unquestionably lowers hygienic quality of water. In every population, there is a percentage of carriers of typhoid, para-typhoid, gastro-enteritis and other disease bacteria. Even washing of hands may contaminate water. Arthur D. Weston, Chief Eng., Mass. Health Dept., states that in '13, as a result of allowing fishing, there occurred about 1,500 cases of gastro-enteritis. Prof. Beard of Stanford Univ. found typhoid organisms in sewage of Palo Alto, with

no carriers reported and only 2 or 3 cases of typhoid in 10 yr. If water were not polluted it certainly would not be improved, nor would it be just as good. Even if water is chlorinated, best present day practice is to put least possible burden on treatment plant, chlorinating being regarded as additional safeguard, not sole barrier. Portions of the Lake San Leandro watershed, subject to effective control against water pollutions. It is axiomatic in water works sanitation that quality of water should improve from source to consumer; fishing or recreation on lake would defeat this purpose. On exceedingly large res. fishing might be permitted where a non-fishing area can be maintained adjacent to water supply intake. Carl Leipold, Supt. Winnetka (Ill.) Water Filtration Plant, held that tastes and odors occur in Lake Michigan water, presumably due to fish eggs and milt from large numbers of yellow perch. Human history has amply demonstrated that sanctions and privileges once granted, are rescinded or suppressed with greatest difficulty; opposite is also true—more and further privileges are obtained by fair means or foul. If fishing is permitted in Lake San Leandro, demand would be made for same privileges throughout system. Numerous difficulties and much grief would be involved in fee and rental system. Expert opinion is against use of impounding res. for fishing and recreational use. C. A. Holmquist, Director, Sanitation Div., N. Y. State Health Dept., states that dept. is very much opposed to permitting fishing in water supply res. A. D. Weston states boating, fishing and recreational uses of res. inevitably lead to contamination. Metcalf and Eddy, Cons. Eng. of Boston, Mass., hold that commissioners should not jeopardize health of citizens of Marlborough by permitting fishing and that commissioners would accept grave and unnecessary personal responsibility by such action. Warren J. Scott, Director, Div. of San. Eng., Conn. State Health Dept., stated that it was necessary to stop fishing, after feces were found on shore of a res., under strict regulation. Gordon M. Fair, Prof. of San. Eng., Harvard, referring to water supply of Mass., stated: "It does not seem to me that any water commission will willingly take on the responsibility of continuing to guarantee the hygienic safety of a water supply such as yours if safeguards such as the prohibition of its use for fishing and other recreational purposes are abandoned." Conn. state laws oppose use of res. for any purpose other than water supply; courts have concurred. Penna. has similar regulations. On Pacific coast fishing and recreational use of water supply res. prohibited in San Francisco, East Bay Municipal Utility District, Pasadena, San Jose, Portland and Seattle. Author in appendix of report cites numerous authorities and gives excerpts from their writings, opposing use of res. for fishing and recreational purposes.—*Samuel A. Evans.*

Design and Construction of the Carron Reservoir. PATRICK BANNATYNE GLENDINNING. Surveyor (Br.). **95:** 721 (Jun. 2, '39). (Presented before Inst. of Water Engineers). Carron Res. has been constructed for Sterlingshire and Falkirk Water Board. It is an impounding res. on upper reaches of Carron R. Will have capac. of 4.3 billion gal. (Imp.). Undertaking is one of largest in Scotland, providing for pop. of 100,000. Will supply 21 m.g.d. (Imp.). Res. will have area of 900 acres and length of 3¼ mi. Main dam is 1460′ long, with max. height of 42′. Middle 450′ is of masonry; remainder is

earth embankment with puddle-core wall and cut-off trenches. Center 200′ of masonry section is spillway. Upper Dam, which prevents water from spilling over into adjacent watershed, is earth embankment with ave. height of 15′ and total length of 1,560′. *Discussion.* G. F. Atkinson. *Ibid.* p. 751 (Jun. 9, '39). Noted that cost of £30 per mil. gal. (Imp.) for storage in res. is unusually low as an English res. with which writer is acquainted had cost £230 per mil. gal. Attributed this to some features of Scottish res. with which Englishmen were not acquainted.—*H. E. Babbitt.*

The Ladybower Reservoir. Anon. The Engr. (Br.) **168:** 440 (Nov. 3, '39). A res. to hold between 5,000 and 6,000 million gallons (Imp.) is being built in Derwent R. Expected that yield from 50 sq. mi. watershed will be 55 m.g.d. (Imp.). Dam consists of earthwork embankment with core of clay puddle founded on a concrete cut-off wall. Embankment is 1250′ long, 140′ high above river bed, and contains 900,000 cu. yd. of material. Upstream face will have a slope of 3:1, and will be protected by a cover of stone "beaching" and stone "pitching" on upper part. Downstream slope varies between 1.5:1 and 2.5:1 with intervening berms at suitable intervals. Will be a 12-ft. roadway along top of dam. Discharge tunnels to carry diverted waters of river are 12′ x 12′. Water drawn from res. during normal working will flow in pipes situated in 2 valve shafts, one on each discharge tunnel. Shafts are 12′ in diam. and provide 3 outlets at different levels, each opening being provided with duplicate valves in tandem. 2 overflows consist of bell-mouths, 80′ in diam. at top, gradually diminishing to 15′ at point where they merge with vertical shafts. At the bottom shafts are connected to horizontal tunnels which discharge into tailbay. Shafts were designed as a result of tests on models. Expected that work will be completed in '41.—*H. E. Babbitt.*

Caron Water-Storage Project. J. I. Strong. Can. Engr. **77:** 20: 2 (Nov. 14, '39). Years of consideration and planning will culminate in completion of new water supply for Moosejaw, Sask., next spring. As far back as '11, survey was made for supply from South Saskatchewan R., but lack of finances have been insurmountable obstacle. Present supply is derived from gallery constructed in sands of valley of Sandy Creek. For several years has been necessary to ration water to citizens and impose hardships on industry. Prairie Farmers Rehabilitation Association made survey and new supply system is being constructed under their supervision. Water from Saskatchewan R. will be conducted 68 mi. by open canal to junction of Sandy and Thunder Creeks, below source of existing supply, where it will be spread for absorption into natural underground storage res., approx. 1000 acres in area. Res. consists of 25′ to 30′ of sand bounded on both sides and below by impervious clay; water level at present time is within 7′ of surface. Water will be extracted as required through 192 well points capable of delivering 3 m.g.d. Present demand is less than 1 m.g.d. Expts. have shown that land above res. will absorb 1–2 m.g.d., but 50 acres were prepared for absorption to allow large factor of safety. Owing to shifting sand, usual type of intake could not be employed in Saskatchewan R. Timber-crib intake, 500′ long, 14′ wide and 8′ deep, surrounded with graded gravel, was constructed approx. 8′ below

low-water level in water-bearing sand at edge of river. Four 2,600-g.p.m., electrically-driven pumps will lift water 350′ through 24″ pipe, 3,800′ long, to height of land at start of canal. Pumps will operate about 20 hr. per day (off peak) for about 210 days per yr. (shut down during winter). Approx. 2 mi. from start of canal, storage res. has been constructed to balance supply and demand. Canal has bottom width of 3′, 1½ on 1 side slopes and min. depth of 3.5′. Total fall in 68 mi. is 175′. Ave. velocity in canal will be 1.5′ to 2′ per sec. and seepage loss has been estimated at 40%. Sealing may be found necessary. Provision was necessary at no. of points for passing run-off water under canal. Surface drainage is permitted to enter at few points.—*R. E. Thompson.*

Water Control at Pasadena. C. W. Sopp. W. W. Eng. **92:** 1126 (Aug. 30, '39). The principal storage res. for Pasadena is Morris Res. located in San Gabriel Canyon, about 4 mi. north of Azusa, Cal., max. depth, 245′. Seasonable distribution of algae follows general laws: diatomacae—*asterionella melosira* and *synedra*—have occurred in cool spring and fall mo. of Mar. Apr., Nov., and Dec.; chlorophyceae—*staurastrum, pandorina* and *eudorina*—have occurred in Jun. and Jul.; cyanophyceae—*anabaena*—has occurred in Aug. and Sep. Do not show up yr. after yr. Vertical distribution depends largely upon depth to which sunlight penetrates; diatoms growing best in cooler water and apparently requiring less sunlight have much greater vertical distribution than do greens and blue-greens. *Asterionella* and *melosira* found to depth of over 105′, while *anabaena* absent in 40′ depth when present in concn. of 972 units at surface. Water in res. sampled twice weekly; this found sufficiently frequent to detect sudden increase in algae content. Water sampled at 20′ levels at outlet tower and at surface in various sub-areas of res. Growths not permitted to become excessive, limit before treatment varied according to type and season; higher concn. permitted where natural to expect decrease in short time. $CuSO_4$ used based on standards of Hale, corrected for temp., alk., CO_2 and organic matter. Experience best guide, ⅓ usual starting dose of 83 lb. per mil. gal. for *eudorina* and *pandorina* has been effective, whereas in case of *anabaena* at one time 2 lb. per mil. gal. was ineffective (instead of 1.67 corrected dose), but 4 lb. was found satisfactory. Effect of treatment continues for some time, one 4.3 lb. per mil. gal. treatment caused *asterionella* and *melosira* to decrease for 17 days. Res. naturally stocked with trout; 2 lb. per mil. gal. $CuSO_4$ has not killed fish, 5 dead found in entire res. after 4 lb. dose, and 30 after dose of 5.5 lb. Lab. tests resulted in change of NH_3 = Cl ratio from 1:3 to 1.2:6.3 with improved results and saving of $400 per yr.—*Martin E. Flentje.*

Currents in the Lake of Constance. I. M. Auerbach. Deut. Wasserwirtschaft **34:** 193 (May '39). This celebrated body of water, Lacus Brigantinus of the ancients, Bodensee of the Germans, lies between Switzerland and Germany at 1283′ elevation. It is about 40 mi. long and 9 mi. wide. Area is about 200 sq. mi. and greatest depth, about 950′. In '19 author began study of the chem., physical, and biological conditions prevailing in this lake. Has continued ever since and hopes to establish them on a permanent basis. Well known that in large lakes temporary currents develop due to wind,

barometric, or thermal gradients; but such currents are mostly confined to the region above the metalimnion. No suspicion entertained that, due to Rhine R., which enters near southeastern extremity and flows out at northwestern, there exists at all times in the deeper layers and sometimes even at surface a system of strong, steady, permanent currents practically over the whole area. Yet such is the fact. In winter, observations are difficult, but every spring and summer careful determinations of direction and velocity of underlying currents yield practically identical pictures. Moreover, by fortunate chance, found possible to confirm by chem. tests, at certain seasons, results obtained. Results are strikingly visualized in a series of 22 maps and diagrams. Thought that they will prove of much interest, not only to biologists, but also to water construction engineers, hygienists, and pisciculturists; further, it is hoped to kindle interest for prosecution of similar studies on other large bodies of fresh water. II. *Ibid.* **34:** 358 (Aug. '39). Since its diversion in '05, the Alpenrhein (i.e. Rhine above Lake Constance) has been carrying down in its new channel a great volume of detritus. Shrinkages in depth extend for some distance from new mouth and reach 15 m. at some points. When snows melt in May, composition of water changes, and thus it became possible to trace its course, both as to breadth and depth, down the lake, its gradual dilution with lake water, and even its rate of travel—about 600 or 700 m. per day. Lake gradually narrows as it approaches city of Constance, whence, for 10 or 12 km., it looks like a river and is caller Seerhein (Lake Rhine), again expanding out into Untersee (Lower Lake), 32 km. long, of very irregular outline, with maximum breadth of 15 km., maximum depth of 45 m., and lower in level by 35 cm. Where lake widens, main body of water passing down keeps to Swiss side. Characters of 2 lakes are in sharp contrast. Upper lake typically oligotrophic, rich in oxygen throughout its depth, plankton organisms comparatively few, and their nourishment, scanty. Lower lake is eutrophic, oxygen content at deep levels low or absent, hydrogen sulfide occasionally present, abundant plankton life and nourishment, dead organisms sinking to bottom and decomposing. Sewage from riparian resorts and factories seems steadily overtaxing self-purification capacity, especially where circulation is deficient; fishery is already suffering and water now needs treatment to render it safe for drinking. Ameliorative measures are called for and all wastes not thoroughly purified should be excluded. On other hand, water of upper lake, and especially below the depth of 40 m., is unexcelled as drinking water. Part which currents play in promoting self-purification is discussed. Untersee a good object lesson because conditions are so much better in that part of lake where currents prevail and in Seerhein. Relation to fish life also discussed and would seem to be not inconsiderable. During summer months, currents are nowhere noticeable at depths exceeding 30 m. In conclusion, undesirability of making any changes in present course either of Alpenrhein or of Hochrhein (i.e., Rhine between Lake Constance and falls of Schaffhausen) without carefully weighing its probable effects upon regime now established, is strongly urged.—*Frank Hannan.*

Anopheline Breeding: Suggested Classification of Ponds Based on Characteristic Desmids. W. C. Frohne. Pub. Hlth. Repts. **54:** 30: 1363 (Jul. 28,

'39). Use of vague terms "borrow pit," "marsh," "bog," "fish pond," etc. in describing mosquito environments limits usefulness of larval collection data gathered during last quarter century. Ecological requisites of a species need to be defined. Paper proposes a preliminary natural classification of ponds for greater exactness. 26 relatively shallow bodies of quiet water either natural or artificial occupied to considerable extent by larger plants are compared from standpoint of their biotas, source and nature of water, permanence, pH and individual variability. Ponds studied were situated in coastal area of South Carolina and Georgia and observations made over period of one year including unusually dry summer period of '38. Selected data are summarized in tables to compare various ponds. 82 higher aquatic plants listed but were designated as of only general value as environmental indicators. Desmids were selected as good indicator organisms because: (1) the group is large and is represented in almost all fresh water habitats; (2) taxonomy is less troublesome than many groups, e.g. recognition of genera can be made almost at a glance; (3) group contains sensitive "indicator species." (4) no general tendency to produce "bloom" which would monopolize habitat and lessen index value; (5) many species are recovered from guts of mosquito larvae. 23 genera and 89 species of desmids listed and numerical distribution of species and genera in various ponds given in tabulation. When all desmids are included ponds can be divided into:

1. *Desmid-rich class*: averaging 34.9 species per pond; 5 to 18 genera; chiefly seepage water, colored and acid.
   a. *Temporary desmid-rich type*: 10-15 desmids associated with running water.
   b. *Desmid-optimum type*: pH more than 4.2: 30-60 species desmids.
   c. *Sphagnum type*: pH less than 4.2; diatoms quantitatively exceed desmids.
2. *Desmid-poor class*: averaging only 4 to 9 species per pond; 1 to 8 genera; underground or run-off water, colorless and alkaline or neutral.
   a. *Closterium-euglenoid type*: illumination deficient; euglenoid plankton dominant; Closterium only desmid.
   b. *Artesian-water type*: exposed to sunlight; permanent; underground water source; desmids rare.
   c. *Temporary desmid-poor type*: run-off water; Closterium always present.

Variations occur and need for subdivision of types is indicated in some instances when more extensive information becomes available. Anopheline larvae were collected whenever present in ponds but information obtained not considered important in classifying ponds and therefore seasonal notes and quantitative data are not included. Tentative correlations were: *Anopheles quadrimaculatus*, breeding was restricted in desmid-rich class and no breeding at all was found in the sphagnum type. Temporary desmid-poor and the artesian-water types were best for this species. Immature forms of *A. punctipennis* also prefer the desmid-poor types and in addition are associated with running water. Infrequency of larvae of this species in Georgia appears associated with fact that small streams of area drain desmid-rich ponds, whose waters are unsuited. *A. Walkeri* larvae were found only in one subtype of

temporary desmid-rich waters, while *A. crucians* thrived best in the desmid-rich class but was found in all six types. Malariologists are urged to use the proposed key of pond types or one like it to classify mosquito environments, that the Anopheline ecology may be extended.—*T. A. Olson.*

Freshwater Biological Association of the British Empire. Seventh Annual Report. (Yr. ending Mar. 31, '39). Report of director E. B. WORTHINGTON on Assn. activities and particularly research carried out largely at Wray Castle, Assn. headquarters. Staff of approx. 20 scientists engaged in studies of lakes, fish, bacteria in water, fresh water algae, etc. *The Algal Cycle and its Controlling Factors.* Part A. *Changes in the Phytoplankton.* M. ROSENBERG. Fresh water plankton varies little in character the world over, much less so than does character of terrestial organisms. Variation considerable, however, in each individual body of water because of differences in concentration of light, temp. and chemical substances. In English lake district 160 species phytoplankton found in Lake Windermere alone. Gradual increase in organic matter content in this lake has been followed by change in algae, particularly in increase in no. of blue-greens; *Uroglenopsis Americana* an example, appearing only since '32. Treatment of small lake with bone meal in trout fish studies resulted in giving way of original typical desmid plankton, first to *Volvox Aureus* as dominant form, followed next yr. by mass development of blue-green, *Anabaena flos-aquae.* Plankton reverted to original form approx. 2 yr. after treatment. Max. development phytoplankton takes place when water is rich in dissolved substances, depletion of these as result of repeated multiplication of algae is followed by sudden drop in no. Diatoms requiring higher concentration of lime and silica than other groups, most abundant in spring, second smaller mass development occurs in fall in most cases following heavy rains or floods. Organic matter resulting from decomposition of diatom cells supports growth of blue-green algae. Colonial green algae as *Eudorina* also seem to be favored by dissolved organic matter. 3 to 4-week lag found in appearance between organic matter and of blue-green algae. Part B. *Changes in Physical and Chemical Variables.* C. H. MORTIMER. Chem. studies confined to "limiting substances" which due to extreme dilution in water, become depleted, and so limit plant growth, although large quantities of other necessary chemicals present. Limiting substances include nitrogen as inorganic salt and perhaps most important, phosphorus, and in some cases silicon. Studies of L. Windermere show nitrate and silicate high during winter, falling rapidly during phytoplankton growth in May and June when diatom *Asterionella* predominant organism, depletion these chemicals in mid-June stops diatom growth. Death of diatoms liberating silicate, phosphate and large quantities dissolved organic matter changed water so that growth of blue-greens favored. Depletion of nitrate and silicate, rise of dissolved organic matter in surface water layer and accumulation of salts in bottom water during summer clearly shown by analytical results. Inflowing waters important, has been shown wet winters are followed by large diatom crop in spring, dry winters by poor crops. Difficult from chem. tests to foretell start of growth, easier to predict falling off of growth through depletion of limiting substances. Part C. *Bacteria in Freshwater.* C. B. TAYLOR.

The medium, sodium caseinate agar, on incubation for 15 days at 20°C. found to be most suitable for growth of water bacteria, consistently giving highest numbers. Horizontal distribution of bacteria in L. Windermere found to be uniform. Vertically numbers decreased with increasing depth in summer months. Preliminary studies in lake appear to show no significant sedimentation of living bacteria takes place either as cells or attached to particles of organic matter. Astonishing diversity of bacterial species present in lake waters, there appears to be a bacterial flora definitely indigenous to water, flora distinguished from that of soil by consisting almost entirely of rods of various sizes not taking gram stain and by lack of the large group of pleomorphic gram-staining organisms of *B. globiforme* group. NH_3-oxidizing, NO_2-oxidizing, and bacteria capable of fixing atmospheric N present in only small numbers and probably incidental rather than indigenous. Part D. *Lake Deposits.* C. H. MORTIMER. Further use of echo sounding apparatus to determine depth of bottom deposits reported. Results checked by cores from bottom. Study of plant remains in cores has shown presence forms now found in res. with, however, absence of *Asterionella gracilliona*, presently abundant; 14 species found have arctic, arctic-alpine or northern distribution. Reports on faunistic studies and growth of brown trout also given.—*Martin E. Flentje.*

Limnological Studies in Connecticut. GORDON A. RILEY. Ecol. Monographs **9:** 53 ('39). Content of total copper in 3 Conn. lakes varied greatly with season and from 1 yr. to next, quantity ranging from 0.009 to 0.383 mg./liter. Vertical distribution of total Cu was either direct, inverse or dichotomous, depending on relative predominance at different levels of 2 opposing processes, sedimentation and regeneration. Soluble Cu showed direct stratification during stagnation periods; seston and organic fractions were highly variable and tended toward inverse relation. Total amt. of Cu in lake was lowest in middle or latter part of winter, tended to rise slightly at time of spring overturn, remained fairly low through spring, gradually increased during summer and early autumn and rose sharply to max. in Oct. or Nov. Concentration of Cu was never low enough to be ecologically significant factor from deficiency standpoint, but during autumn it was high enough to be toxic to some animals and plants; this was also true to some extent of lower part of hypolimnion throughout summer. Tolerance level of 10 representative freshwater invertebrates was 0.03 to more than 0.5 mg./cu. liter. 2 animals with highest tolerance were hypolimnetic forms. At least 5 factors that affect Cu content of lake waters are: (1) Precipitation, which lowers Cu content by diln., (2) sedimentation, the removal of Cu from soln. by adsorption on org. matter, (3) regeneration from mud, (4) liberation of Cu from littoral plants in autumn when they die and decompose and removal of Cu from water during growing season, and (5) liberation of Cu in autumn by decomposition of vegetation surrounding lake. 42 refs.—*C. A.*

Studies on the Limnology of High Mountain Waters. O. STEINBOCK. Int. Rev. Hydrobiol. **37:** 467. Discusses limnology of different types of mountain waters, i.e., those above upper limit of forest. Formation of holes in glacial

ice is discussed and characteristics compared with those of holes found in pack ice. Lakes at edge of glaciers do not contain many living organisms. Flora and fauna of glacier streams vary with type of stream. Rapid, turbid streams contain few living organisms, but in streams which flow smoothly some organisms, e.g. larvae of *Brachydiamesa* and *Ecdyurus* are found quite close to glacier. Sometimes glacier gives rise to a no. of small streams which flow through the moraines at sides. Streams leaving moraine are clear and resemble biologically a clear mountain stream. Mountain streams differ from glacier streams by being clear throughout year and by having relatively constant flow; richer flora and fauna is thus able to develop. Several mountain lakes are described with special reference to changes in temp. gradient. May be divided into cold lakes, i.e., those on the edge of glaciers or firm snow and those formed from glacier streams, and lakes which are warmer at surface. Latter may always remain cold at bottom or in summer temp. at all depths may rise. Nomenclature of the various types of mountain lakes is discussed.—*W. P. R.*

Reservoir Silting Cut in Half Through Erosion Control. ANON. W. W. Eng. **92:** 1267 (Sep. 27, '39). High Point, N. C. 1½ billion gal. capac. reservoir now receiving 50% less sediment than in '34 due to erosion control on watershed. In '34 loss of over 1 ton topsoil from each acre on 40,000 acre watershed found. Watershed composed of land of which <34% was forest land, 30% in cultivation mostly for corn, small grain and tobacco, 16% in pasture. Rows now cut across slopes following contours of land, terraces carry excess water slowly off fields into closely vegetated outlets and woodland. 4 yr. saving consists of 21 cu. ft. of soil per acre. Ave. rainfall period, '28 to '34, was 46″; '34 to '38,—50″+.—*Martin E. Flentje.*

Silting of Reservoirs. ANON. Public Management **21:** 251 (Aug. '39). North Carolina municipal res. are losing an ave. of nearly 1% of original capacity annually, equivalent to a total yearly cost of over $100,000, as a result of silt deposits from erosion, according to a recent study of the U. S. Dept. of Agriculture. Experiments in soil erosion control on High Point city watershed, however, showed a 50% reduction of silting in 4 years.—*Anon.*

Fish in Reservoir Resist Chemical Poisoning Effects. ANON. Eng. News-Rec. **124:** 522 (Apr. 11, '40). Carp which gained access to freshwater lagoon on Treasure Island fair grounds, San Francisco, when barrier between it and fish pond was accidentally broken, soon made water muddy by their burrowing and threatened to puncture water-tight clay lining. Lagoon is 33″ in depth, 7 acres in area, and has capacity of 7 mil. gal. Over period of 2 weeks, successive dosages of 1.3, 1.7, 1.7, 8.5, and 8.5 p.p.m. failed to kill a single fish. After 2 heaviest dosages, many fish came in close to shore and were so sluggish that they could be removed with rakes; 910 were removed in this way. Following this, turbidity of lagoon water was reduced from 150 to 18 p.p.m. with 3 g.p.g. dosage of alum. Final treatment of copper sulfate was applied to clear water but no dead or sluggish fish appeared; and within 5 days turbidity had increased to over 70 p.p.m. Rotenone, constituent of derris root, was then

tried in 2% solution. Dosage sufficient to give concentration of 0.06 p.p.m., double that reported to be fatal to fish in 24 hr., was applied with high-pressure spray. During succeeding 48 hr., 12 sluggish fish came to surface and were picked up. Turbidity remained unchanged. As last resort, lagoon was thoroughly seined with net 200′ long and 4′ wide, with floats at top and wts. at bottom. In 3 days, 108 carp averaging 0.8 lb. in wt., were removed. Several fish eluded net by jumping over it, but turbidity was reduced to acceptable amount. Lab. tests indicated that initial dosages of copper sulfate may have been rendered impotent by adsorption on colloidal clay.—*R. E. Thompson.*

Evaporation at Charleston, S. C. ANON. Pub. Wks. **71:** 1:14 (Jan. '40). 34 yr. record kept of evapn. from water surface of Goose Creek storage basin of Charleston (S. C.) Water Dept. Ave. annual evapn. from water is 48.35″ and from land 81.08″. Max. from water 65.57″ and min. 34.23″. From land, max. 110.63″, and min. 59.03″. Evapn. from water detd. from vessel, approx. 6″ diam., suspended in second vessel about 2′ in diam., immersed and floated in res. off shore; loss detd. daily. Ave. evapn. from water for 12 mo. of yr. given respectively: 2.32″, 2.62″, 3.91″, 4.84″, 5.59″, 5.49″, 5.27″, 4.93″, 4.35″, 4.01″, 2.80″, 2.22″.—*Martin E. Flentje.*

DAMS

The Haweswater Dam. DELWYN G. DAVIES. The Engr. (Br.) **169:** 141 (Feb. 9, '40) and Wtr. and Wtr. Eng. (Br.) **42:** 62 (Mar. '40); **42:** 151 (Apr. '40). First installment of scheme to increase supply of Manchester water works consists of construction of dam at Haweswater, 9 mi. of aqueduct, and 2½ mi. of pipe line. Haweswater Dam is being constructed at outlet of most easterly of lakes in English Lake District, about 80 mi. from Manchester. Surface area of lake will be increased from 342 to 974 acres. Annual ave. rainfall on watershed varies between 52″ and 97″, with a mean of 81.7″ on a watershed area of 7,970 acres, giving an estimated yield of 33.6 m.g.d. (Imp.). 227′ long spillway is expected to have max. head of 1.93′. Dam is monolithic buttress structure built of massive sections, with following dimensions: overall length, 1540′; length of block, 35′; max. height from lowest foundation, 144′; max. height from ground level, 100′; base width, 112′; width at water line, 7′9″; vol. of concrete, 140,000 cu. yd.; and vol. of excavation, 77,000 cu. yd. Each buttress has a bevelled face to the head and a splayed tail. Head and tail converge upward and merge to form solid dam for top 20′. 4 entrances through downstream face permit access to exposed foundation and examination of face to within 6′ of water. Two 36″ needle-valve controlled scour pipes convey compensation to stilling pool. Alternative 40″ scour pipe is located higher in face as emergency emptying outlet. Collective discharge is 520 mil.gal./sec. (Imp.). Buttress head has bevelled wings to face to eliminate bending and diagonal tension. Splayed tail offers greater lateral stability and resistance against buckling under load. Buttresses are independent of their neighbors to prevent torsion. Uplift is minimized because of exposed foundation between buttresses. Quantity of concrete is estimated 73% of that required for a similar dam of solid type. Excavation accomplished with overhead cableways. Foundation on andesite, compact rock weighing 177 lb. per cu.ft. with

a crushing strength of 940 to 2300 tons per sq.ft. Most of rock was removed by blasting. River was first diverted from normal bed across site of dam to a channel cut in higher ground. Cut-off trench was cut to depth of 6′ below normal foundation. Immediately prior to concreting foundation was coated with thin layer composed of 1 part cement to 3 sand. Wood forms on rock foundation and about 6″ outside of normal plan section of buttresses were used for first concrete lift. Subsequent lifts were 4′ high. High tensile steel concrete distributor delivered concrete in thin layers over whole area of 2 adjacent buttresses on consecutive days. The max. fall of concrete was about 5′6″ which was exceeded when placing concrete in foundations. Max. output of concrete was 275 cu.yd. in one day. Concrete mix used was 1:3.13:3.77 by weight, determined through lab. investigation.—*H. E. Babbitt.*

St. Saviour's Dam, Guernsey. The Engr., (Br.) **169:** 300 (Mar. 29, '40). To augment existing water supply for States of Guernsey a dam and res. are being formed in parish of St. Saviour. Res. will have estd. capac. of 200 mil.gal. (Imp.) and max. depth of about 70′. Dam is mass concrete, gravity structure, 860′ long, with max. width at base of 86′. Height is 125′. Mass of dam is being constructed of 7:1 concrete, and upstream face of 4:1, placed simultaneously. Whole of upstream face is to be united. Site consists of soft material overlying rock to depths varying from 1′ to 19′. Short distance upstream from site is boundary between diorite gneiss and older granite gneiss, in part accounting for abrupt changes in nature of rock encountered in excavation. To ensure water-tightness grout holes are being drilled at 6′ centers in 2 rows along whole length of cut-off trench. To prevent uplift, drains have been laid over foundations downstream of cutoff trench, and pressure relief pipes lead away from these drains at convenient points into inspection gallery. Several electrically operated thermometers are being embedded in one of blocks and connected to central indicator. From these instruments max. rises in temp. will be obtained, and subsequently cooling rate of masses.—*H. E. Babbitt.*

Mount Bold Dam, South Australia. ANON. Wtr. and Wtr. Engr. (Br.) **42:** 20 (Jan. '40). Dam on Onkaparinga River was commenced in '32 and completed in '38. It is a constant-radius arch type concrete structure with gravity abutments. Spillway is 227′ long and 135′ above stream bed. There are 131,523 cu.yds. of concrete in structure. Reservoir contains 6,688 mil.gal. (Imp.) of water. It is supplied from a catchment area of 150 sq.mi., on which ave. annual rainfall is 33.84″. Outlets from the dam, through needle valves, lead to 48″ diam. steel pipes.—*H. E. Babbitt.*

Two Dams in Mexico. ANON. The Engr. (Br.) **169:** 54 (Jan. 19, '40). Two of most recent irrigation dams constructed by Mexican Govt. are Salinillas Lake Dam in Nuevo Leon, and at Madero, Hidalgo. Former structure provides lake of 12,100 acre-ft. capac. and outflow of 178 c.f.s., which can be doubled during 230-day irrigation season. Latter provides a res. of 25 million cu.m. capac. Construction work comprised 3 main parts: diversion tunnel, main dam, and spillway. Diversion tunnel has cross-sectional area of 138

sq.ft. for a length of 572′. Dam is of rock-fill type; 159′ high, 139′ long at bottom, and 16.2′ thick at crown. Free crest spillway is provided in small saddle on hillside. Spillway is 162′ long with max. capac. of 20,000 c.f.s.—*H. E. Babbitt.*

Engineering Geology Problems at Concha's Dam, New Mexico. IRVING B. CROSBY. Proc. A. S. C. E. **65:** 29 (Jan. '39). Large dams on uncemented shale or siltstone foundations present difficult geological and engineering problems. Methods pursued in study of such problems at Conchas Dam are instructive because it is a high dam on a soft, weak shale or siltstone. Foundation investigations have involved extensive geological field studies, an extensive drilling program, large drill holes, tunnels and test shafts; physical and chem. tests; and tests adapted from soil mechanics. Where precise lab. methods could be used their results were applied to conditions in the ground. Application of precise methods to geological data involves exercise of judgment in discriminating between degrees of precision of information at hand. Unwarranted confidence might result in disaster.—*H. E. Babbitt.*

Hollow Dams. JOHN W. LEWIS. W. & W. Eng. (Br.) **41:** 569 (Dec. '39). Although final section for a mass gravity dam, designed in accordance with conventional principles, will give safe structure if founded on sound rock, enormous mass of material involved is used to least advantage. Saving would be effected by omitting material, leaving series of parallel slices in form of buttresses. There will be effective drainage through the open spaces between buttresses by which uplift pressure will be relieved, factor of safety against overturning would be increased from 2.20 to 5.00, while sliding factor would be reduced from 0.75 to 0.5. Modification of buttress spacing and thickness may result in evolution of cellular structure with nearly uniform foundation pressure, factor of safety against overturning of 4.0 and sliding factor of 0.60, with reduction in cost of about 30%. Sloping inner face of dam is important feature of structure, another advantage of which is possibility of using whole dam in spillway section. Water-bearing members are deck slabs spanning between corbels on upstream faces of buttresses. Feature makes entire structure somewhat flexible. Appreciable water load is transmitted to foundations to resist sliding and overturning and there is no uplift. Stresses in individual sections are comparatively easy to determine and foundation subsidence, or even earthquake, would cause only partial failure of buttress structure. May be advantages in wider spacing and greater thickness of buttresses. Forming slab partly as an arch on downstream side supporting flat upstream face has been suggested. Slab might act as brace in event of lateral movement. Round buttress design consists of series of buttress units each having towards water side an enlargement joined laterally with enlargement of adjacent unit in such manner as to form continuous upstream face. Stresses are compression only, no lateral bending moments, and no reinforcement is required. In massive-buttress type, for heights of 100′ or so, saving in comparison with mass-gravity dam is in ratio of 13:17. Important point to be noted in this type is radial bearing surfaces of slabs which along with vertical interlocking joints are heavily asphalted.—*H. E. Babbitt.*

Dam Foundations. FERDINANDO PAGLIARO. 83 pp. Pub. by Ed. Nicolai, Pistoia, '38. l. 25. (Review by LEO MADDALENA in Ann. Lavori Pub. (Rome) **77**: 539 (May '39)). Author, who is Director of Dam Engineering in Public Works Ministry presents in 3 chapters lessons gathered from his wide experience. First chapter treats of preliminary investigations. Priority in really enlightened legislation on this point is claimed for Italy. Dam engineer's task is difficult and hazardous one of reversing naturally established conditions. First care must be to acquire accurate and intimate knowledge of the whole rocky complex with which he must deal. Must understand thoroughly stratification and geology of his site and must be able to locate his boreholes unerringly, so as to disclose the nature of the hidden interior of the rocks and especially any weak points. Must be able to prescribe and to apply correctives to the latter. Properties of rocks which concern him are permeability and mechanical resistance. These are treated in very thorough fashion, with numerous examples from practice of pitfalls and difficulties encountered and of how to cope with them. Only very great experience can guide engineer to lay his foundations in such fashion that subsequent costly corrections will be avoided. Thanks to State advisory service and to legislation already referred to, percentage of such costly errors in Italy during past 10 yr. has become negligible. In the second chap. instruction on how and where to bore and how to interpret results is given in generous measure, always with aid of examples from practice. Chap. concludes with list of geophysical methods and their application, with special emphasis on those based upon electrical conductivity. Third chap. deals with treatment of defective rock. All rock is subject, more or less, to influences which may bring about deterioration. Injections of various kinds are in use as remedies, the chief being cement. In conclusion is given the Italian dam legislation. Reviewer emphasizes great practical value of this book as a guide to the avoidance of errors of which the correction is extremely expensive.—*Frank Hannan.*

Lateral Spillway Channels. THOMAS R. CAMP. *Closure of discussion.* Proc. A. S. C. E. **66**: 107 (Jan. '40). Scheme proposed for simplifying design of wash water gutters by equating slope term to friction term raises question of desirability of fixing slope for sole purpose of simplifying computations. Simpler to make bottom level. With level bottom, depth may be approximated quickly by computing drop in water surface and increasing it by about 10% to allow for friction. Advantages in level bottom from both construction and operation viewpoint. Pointed out that procedure neglects component of lateral inflow parallel to axis of flume. In horizontal plane no such component exists for small channels dealt with by sanitary engineers. Such is not case, however, for dam spillways and for tail-race channels. Method makes possible starting of design of side-flow spillway at down-stream end where depth, cross-sectional area, and rate of flow are known. For assumed value of increment of weir length and corresponding increment of discharge a trial position of weir crest may be set for down-stream end, and estimate made of value of first increment of rise in water surface. After suitable adjustments are made, process may be continued for succeeding increments of weir crest until length of weir is obtained which will deliver required overflow.—*H. E. Babbitt.*

Flash-Board Pins. *Discussion of previous paper.* Proc. A. S. C. E. **65:** 1803 (Dec. '39). JOHN E. FIELD: Spillway costs are no inconsiderable part of entire cost of dam and with "fool-proof" collapsible flash-boards cost is reduced materially and much of objection to flash-boards in spillways will be answered satisfactorily. In '05 writer provided "fool-proof" low-crest earth dam to relieve flood flows in large canal. If pipe-supported flash-boards had been available project would have profited greatly. *Ibid* **66:** 185 (Jan. '40). JULIAN H. WHITE: Reduction of pressure at top of flash-boards, due to overflow, and rise of water against boards beneath nappe can cause error in head at failure in excess of 2%. With vertical boards tests show pressure head at bottom, and for some distance up, to be greater than depth by an amount very nearly equal to velocity head. With inclined boards, increase in pressure at bottom is not so pronounced. Reduction in pressure is function of total head on crest only. When nappe is ventilated pressure exerted against flash-boards, and distribution is same as for static condition. Rise of water behind nappe of a weir is not due entirely to existence of partial vacuum, but partly caused by reaction of water being turned to its final direction of departure as it strikes floor. Vacuum that may exist under unventilated nappe can vary over wide range. Fortunately, relationship between bending moment and head on boards is such that effect of any error in moment on water surface elevation is greatly reduced. In many flash-board installations change in head due to overflow and rise of water against boards beneath nappe will be very small. *Ibid.* **66:** 671 (Apr. '40). HARRY H. HATCH: Knowledge of the fact that the value of the modulus of rupture per unit area is reduced with increase of the pipe diameter is of vital importance. The authors report a 20% reduction between ¾-in. and 3-in. pipes. Since it is uncertain that the same rate of reduction will be applicable to pipes of larger diameters data showing the behavior of a 5-in. pipe of the Cobble Mountain spillway flash-board are of interest. Computations show the difference in the ultimate unit stress to be around 3% in favor of the theoretical section modulus.—*H. E. Babbitt.*

Water Pressure Indicators for Use in Earth Dams. DAVID R. MAY. Eng. News-Rec. **123:** 212 (Aug. 17, '39). Observations of water elevations in wells having been found unsatisfactory, U. S. Bur. of Reclamation now measures pore-pressures in embankments with diaphragm-type hydrostatic pressure indicators. Each indicator measures pressure of percolating water at one point, and from data obtained, saturation (zero-pressure) line, stream lines and frictional forces of flow are derived. Modification of diaphragm principle of Goldbeck earth-pressure cell is employed. With soil pressure held back by porous disk, water pressure in embankment holds thin metal diaphragm against contact button within indicator. During test, air pressure in indicator, which is measured by gage at test set, is gradually increased until diaphragm is forced away from contact, extinguishing lamp at test set, gage pressure at that instant equalling water pressure at indicator. Indicators are 1″ diam. and 2″ long, have gold-plated diaphragm of 0.0015″ brass and are connected to test set by $\frac{5}{16}$″ copper air tubes enclosing insulated copper wires. Indicators are sensitive to pressure difference of <1″ of water. About 30

indicators distributed through each of several cross-sections of dam, with separate tubes leading to terminal boards at crest. Installations are made in holes drilled in completed embankment, several being placed one above another in each hole. Each indicator surrounded by small sand pocket and rest of hole backfilled with grout, making each hole equivalent of several individual wells opening at different depths. Pressure measurements taken at least every 2 weeks.—*R. E. Thompson.*

Grouting to Prevent Leakage Around an Earth Dam. ANON. Pub. Wks. **70:** 7:12 (Jul. '39). Description of method used by Marion Co., Kansas in stopping leakage through a 1200′ long earth dam, 300′ wide and with a 200′ wide spillway. With reservoir full, spring below dam flowed 1095 g.p.m. In stopping leak 2 sets of drill holes required; grout used consisted first of 1 part cement, 12 parts clay and 1 part aquagel; later the aquagel was omitted. Methods given in considerable detail; leakage finally reduced to 15 g.p.m. Among suggestions given based on this experience are: (1) approx. level of porous stratum must be determined and all holes grouted to point slightly above this; (2) where underground flow is sufficient to carry away grouting material, speed with which injection is made is very important and ordinary highway mud jack does not have this speed; (3) excessive pressure in grouting must be guarded against; (4) sifted clay must not be stockpiled or clogs will re-form; (5) if operations stopped more than 4 to 6 hrs. holes must be flushed thoroughly with clean water to prevent loss for future grouting.—*Martin E. Flentje.*

The Sodium Carbonate Method of Lining Canals and Water Courses for Preventing Seepage Losses. AMAR N. PURI. Punjab Irr. Research Inst., Res. Pub. **4:** 12:11 ('39). Satisfactory results were obtained by digging out 1′ of canal bed, laying 2″ of pulverized earth which previously had been determined to be suitable for purpose, sprinkling with solution of sodium carbonate (6.6 lb./cu. ft. water), laying second 2″ of soil and sprinkling in similar manner and finally covering with 8″ of original channel silt. Apparatus and method for determining percolation resistance of sodium carbonate-treated soils in laboratory are described.—*C. A.*

HYDROLOGY

Fifth Conference of Local Directors of Italian Hydrographic Service. Ann. Lavori Pub., **77:** 1067, (Oct. '39). Held at Turin 21 to 25 July, '39. Leading topics scheduled for discussion were as follows: (1) Glaciological studies—inclusive of methods employed to arrive at a true hydrological balance and of measurements of glacial masses. (2) Definition of an "ordinary flood" as judged by extent of inundation. It is not yet possible to formulate the above inasmuch as different ideas prevail as to what should be regarded as an ordinary flood. In Po valley, it is regarded as that flood which is equalled or exceeded in 75 yr. out of every 100; but this standard would not be generally accepted elsewhere in Italy. (3) Rainfall characteristics, seasonal and local. Imperative duty of diligently compiling and evaluating accurate data on widest scale possible is strongly urged. (4) Flood characteristics and espe-

cially peak flows. Total flows, peak flow and relationship possibly traceable between it and mean flood flow, as also that between total flood flow and rainfall. (5) Research work on ground-water migration—exchanges taking place between ground-water and surface waters. As a result of considerable activity in this field, better understanding of ground-water and its movements has been attained. (6) Organization and distribution of work carried on by the Service. Brief description is given, with comments thereupon by the president. Stream-flow measurements are regarded as principal task of Service. (7) Presidential remarks. After complimenting Service upon great progress recently effected, he announced that publication of *Annali Idrologici* is expected very shortly and urged upon all to expedite as much as possible the appearance of future issues. Other useful publications of Service are referred to. Topics for next conference will soon be announced and will include flood control works with a critical examination of existing works as to their effectiveness and as to any unforeseen shortcomings. Also problem of transportation of silt and suspended matter will be scheduled. Two visits of inspection formed part of the conference; on July 21 to the important hydroelectric developments on the Dora and Cenischia rivers and the Mont Cenis reservoir, and on June 25, to the city and port of Genoa. Minor excursions on other days included the Canale Cavour irrigation works, the Vercelli rice-growing experimental station, and plants on the Marmore in the Val d'Aosta, including Goillet dam now under construction.—*Frank Hannan.*

The Unit Hydrograph Principle Applied to Small Watersheds. *Discussion of paper by E. F. Brater.* Proc. A. S. C. E. **66:** 317 (Feb. '40). LEROY K. SHERMAN: Author has demonstrated conclusively that unit hydrograph method is applicable to small areas. Has been found that: (1) unit of time must be less than, and preferably a fraction of, any concentration period, and (2) unit graph, or percentage-distribution graph, on larger areas, reflects pattern of effective rainfall. Author's study of runoff coefficients would have been more valuable if applied to infiltration capacity. Pertinent to note that forested basins used by author represent extreme limit of low runoff and high infiltration capacity. RAPHAEL G. KAZMANN: The question: "Can infiltration capacity of a watershed be increased by saturating it?" may be logically raised from author's conclusions. Circumstances are conceivable under which such phenomenon might occur. However, if author's statement: ". . . if the runoff coefficient or the infiltration capacity is correlated with quantity of rainfall, the intensity will be taken into account somewhat," is considered, it is not difficult to surmise how a questionable conclusion concerning increased infiltration capacity might have been deduced. *Ibid.* **66:** 690 (Apr. 13, '40). WALDO E. SMITH: Method is inherently approximate. For example, reasonable to expect that a channel full of surface run-off will require longer time to be drawn down to ground-water flow than channel only partly full; yet width of base of distribution graph is taken as constant for all cases, for a given watershed. If author's statement that duration of rainfall within period of rise has no effect is correct, should be possible to put the 60-min. rainfall into one of the four 15-min. periods into which it was divided, without effect upon resulting pluviagraph. Distribution graph is in use in many

places for forecasting flood flows. Depletion curves of ground-water flow are in use in many offices for determining ground-water flow during periods of runoff, as well as between rains. Distribution-graph method, as such, is probably not sufficiently refined to be of service in connection with solution of problems as suggested by author. In meantime it serves as a very handy tool.—*H. E. Babbitt.*

Floods and Flood Control in the Venetian Rivers. L. MILIANI. (Pub. of Italian Comm. for Study of Public Calamities, Royal Acad. of Lincei, Vol. VIII, ('39)). Annali dei Lavori Pubblici, **77:** 1076, ('39). (*Abstract.*) 3 chief rivers, which now empty into Adriatic through common mouth a few km. north of mouth of Adige, are Agno Guá, or Frassine, Bacchiglione, and Brenta. Take their rise among Alps to north and pursue turbulent courses southward through very fertile plain which centers around ancient city of Padua which is encircled by Bacchiglione. Authenticated history of disastrous floods, remedial measures proposed and of those carried into effect extends back about 500 yr. Problem has engaged attention of many of Italy's most distinguished engineers. This volume is second of a series, first of which was devoted to Adige. Author is present head of Italian Water Authority.—*Frank Hannan.*

Flood Flows in Italian Rivers. ANON. Ann. Lavori Pub. (Rome) **77:** 1080 (Oct. '39). Data for 352 peak flood flows are given and include: name of river; location of measuring point; date; area of catchment; its percentage permeability; its mean altitude; elevation of zero altitude above sea level; and peak flow expressed as cubic meters per second, and as liters per sec. per sq. km. of catchment. When for each hydrographic division of country the areas, S, of catchment are plotted as abscissas against corresponding maximum flood flows, q, per sq. km. points obtained seem to lie upon curve:

$$q = q_{100}\left(\frac{S}{100}\right)^{-n}$$

where q_{100} and n are constants for any particular region, but vary for different regions. ★[c.f. formulas of Fanning, Ryves, and Dickens.]★ Value of n depends upon permeability; varies from 0.7 for impermeable, to 0.5 for permeable extremes. Value of q_{100} may exceed 12 on most impermeable watersheds of at least 100 sq. km. in area; while in some impermeable watersheds it may even be lower than 5. For permeable watersheds, spread in values of q_{100} is from a range of 6 to 9 in a few important watersheds down to under 3 for the ordinary. In case of permeable watershed, some of precipitations may finally emerge elsewhere, permanently alienated. As examples of exceptional floods, certain small catchment areas in Liguria, Romagna, and Sardinia record flows of from 33 to 35 cu. m. per sec. per sq. km.—*Frank Hannan.*

Flood Protection Along the Upper Danube. LUDWIG OEXLE. Deut. Wasserwirtschaft. **34:** 214 (May '39). Description, well illustrated with map and diagrams, of levee work being carried out at 2 hitherto inadequately protected sections between Regensburg and Passau. Important tributaries add not a little to difficulties encountered. With completion of these works protection

will be assured to some 6600 ha. Estimated costs and their apportionment as between protected areas, regional authorities, and Reich, are given.—*Frank Hannan.*

Possible and Probable Future Floods. WILLIAM P. CREAGER. Civ. Eng. **9**: 668 (Nov. '39). 30 yr. ago spillway designed to pass a flood 50 to 100% larger than largest which had occurred during a period of record as long as 25 yr., considered adequate. Recently proven that probability method for prediction of floods is entirely inadequate. Data on floods of many years ago and gagings of more recent floods show conclusively that there must be a combination of meteorological conditions which give rise to storms of special class, occurring so infrequently that resulting floods seldom appear on published records of a given river. "Computed spillway flood" by modern methods is flood that would occur at site under worst meteorological and hydrological conditions of record. Spillways, proportioned by modern methods, are safe. Trends shown by figures may serve to refute argument that engineers are "leaning over backwards" in design of spillways. No evidence that climatological conditions are changing perceptibly, hence occurrence of greater floods as time passes must be according to laws of probability. Prediction of floods on such basis involves amount of work beyond possibilities of one man. Study by some public agency would tend to crystallize ideas of engineers on margin of safety to apply in spillway capacity design.—*H. E. Babbitt.*

Lake Maggiore Floods of August 1939. GIUSEPPE MERLA. Annali dei Lavori Pubblici, **77**: 1035 (Oct. '39). June and July, '39, were wet months in this region and on Aug. 4, 5, and 6 torrential downpours occurred in basins of Dora, Sesia, and Toce, all of which flow southwards from Pennine Alps. Last-named is one of three chief affluents of the lake. Had Tresa and the Upper Ticino, further east been similarly involved, record flood must have occurred. Flood in Toce reached proportions quite unprecedented in 71 yr. since great floods of 1868. Crest level of 3.41 meters registered at Sesto Calende, where lake discharges into Ticino, was the highest for 71 yr. in month of Aug., but was exceeded altogether 11 times, or once every 6 or 7 yr., during that period. Sketch map is given of Toce basin, upon which isohyetals of total rainfall for 3 days are traced. Max., of 470 mm., was reached at station near Domodossola; but only small part of area escaped with less than 200 mm. In another figure are given, for comparison, 3 respective hydrometric diagrams showing course of stream levels for 4 days, Aug. 5, 6, 7, and 8, at Candoglia, a few miles up Toce, at Fondo Toce, just where it enters lake, and at Sesto Calende, where lake discharges into Ticino. Another chart gives Aug. max. levels at Sesto Calende for 71 yr. and their curve of relative frequency; yet another, annual max. levels at same station over same period and their relative frequency curve. Expressed as cubic meters per second, max. flows are reckoned to have been in Toce, 1900, and at Sesto Calende, 1700.—*Frank Hannan.*

Analysis of Run-Off Characteristics. (*Closure of discussion by author*, see abstracts Jour. A. W. W. A. **31**: 1246 (Jul. '39), **31**: 1999 (Nov. '39)). OTTO

H. MEYER: Proc. A. S. C. E. **65:** 1423 (Oct. '39). Discharge at any time after time of concentration and after cessation of rain, must be determined by function of outflow from storage. Runoff factor is unreliable but is used where nothing else is available. "Subsurface storm flow" merits considerable study. Distinction should be made between runoff and rate of runoff; and between runoff and discharge. In describing graphically sequence of occurrences on watershed during a storm it is only by visualizing actual physical occurrences that engineers can be sure that mathematical derivations are correct. No assumptions with respect to variations of velocity along a stream should be accepted without most critical analysis. In conclusion should be emphasized that it is physical significance of the shape of the hydrograph, and not empirical mathematical equations describing it, that is important.—*H. E. Babbitt.*

Some Preliminary Results from Run-off Studies on Demonstration Projects. D. B. KRIMGOLD, JOHN L. WEBER AND N. E. MINSHALL. Soil Conservation (U. S. Dept. Agri.) **5:** 187 (Jan. '40). The one or two yr. periods in which rainfall and runoff studies have been made on 20 soil demonstration projects are too short periods for securing accurate data. The unusual rainfall record of Aug. 2, '39 at Safford, Ariz. is of interest: 2.84″ rainfall in 85 min.; 1.47″ of this fell in first 15 min., 0.75″ in 2nd. 15 min., and 0.64″ in remaining 55 min. Max. falling in any 15 min. was 1.60″. Preliminary exam. of the record indicates max. runoff exceeded 900 c.f.s. which is equal to 2.37 c.f.s. per acre or 1500 c.f.s. per sq. mi. Other such preliminary data given to illustrate type of information being obtained.—*Martin E. Flentje.*

The Hydraulics of Surface Run-off. LEROY K. SHERMAN. Civ. Eng. **10:** 165 (Mar. '40). Author tests correctness and limitations of some of assumptions and hypotheses now used in applied hydrology. Hypotheses tested include unit graph, relation of hydrographs of surface runoff and channel outflow, effect of natural detention reservoirs, channel storage, infiltration capacity, or rates of loss. Tests are applied by solution of typical examples based on a single drainage area. Analysis confirms principle of unit hydrograph as to proportionality of ordinates, provided selected time-unit is less than minimum concentration period. Analysis indicates that average loss-rates, except for large storms of relatively long duration, cannot be used as figures for infiltration capacity.—*H. E. Babbitt.*

A Measure of Uniformity and Its Application to Daily Stream Flows. DAVID LLOYD. Wtr. and Wtr. Eng. (Br.) **42:** 10 (Jan. '40). Paper describes measure by which relative uniformity within any series of a quality-characteristic can be evaluated. Gini measure of mean differences is outlined, and use is made of Lorenz ratio, leading to a measure of uniformity. "Stream characteristic" approximates this ideal measure and is compared. Practical application of either measure to daily stream flow assesses relative value of a stream to riparian interests. Initially it will be assumed that we can discuss population (a large collection of individual units from one definite source) of daily stream flows of a particular stream. Average of quantity measures quantitative level; differences indicating inequalities. Gini's *mean difference*, Δ, in sta-

tistical analysis, is average of all differences possible between values to be found between n quantities, i.e.:

$$\Delta + \tfrac{1}{2}\,n(n-1) = (n-1)(a_n - a_1) + (n-3)(a_{n-1} - a_2) + (n-5)(a_{n-2} - a_3) + \ldots$$

Variability can be expressed by areas after an integration process. If all values of character are equal curve of concentration is straight line and forms right triangle with axis of reference. When not equal there is negative skewness and a convex curve at base. Area between curve and hypotenuse is "area of concentration." Its ratio to total area of triangle is 2λ (Lorenz ratio is λ) and is a rational *measure of uniformity.* It will be zero when stream flow contributes whole discharge, and unity when all daily flows are equal. Has been aim to investigate possibility of expressing measure of uniformity, or its synonym called "stream characteristic," in its absolute form as a ratio of areas in terms of frequency distribution actually found or in terms of mean difference. Typical example is solved for daily flow of Blackingstone R. Remarked that at least 7 yr. of records are desirable and that no good can be obtained by comparing analyses of single yr. Some further investigation has indicated that regime of a particular stream tends to a fixed type in every year.—*H. E. Babbitt.*

Studies of Rainfall Intensity. Civ. Eng. **10:** 303 (May '40). *Introduction.* W. W. HORNER: Definite tendency in engineering practice to use mean hourly rainfall values as though they were actually uniform rates throughout hour. If mean hourly rate may be re-expressed as a series of rates, as precipitation really occurred, the resulting infiltration capacity values will be much more nearly the true values that existed. To produce valid results, either in determination of infiltration capacity from precipitation and stream-flow records, or in application of infiltration capacity to design storms in order to estimate flood flows, relationships presented in Breihan's paper must be taken into account. If general values of infiltration capacity are available for a particular area, it is possible to determine probable surface runoff from that basin for each of the three parts of the year, whenever a good series of precipitation values by months is available. *Relation of Hourly Mean Rainfall to Actual Intensities.* ERWIN R. BREIHAN: Study involved an investigation of rains having average intensity of 2″ or more per hour, with a view to determining at what intensities precipitation occurred during each hour investigated. Although heavy rains are usually reported as so many inches per hour, and reported values are often used as mean uniform intensities for whole hour, this never presents true picture of how rain actually fell. *Rainfall Intensities for* 1938–1939, *for Edwardsville, Ill.* H. G. ARMISTEAD, JR.: Object of this study was to find some method of breaking down rainfall intensity data into simple, usable form, with respect to annual occurrence. Tables and diagrams of data are presented. Some of results shown are particularly interesting, seeming to follow same pattern as Meyer's curves for amounts of precipitation occurring in any month. As amount of precipitation in any month increases, there is a proportionate increase in percentage of that rain falling in excess of certain different rates.—*H. E. Babbitt.*

Studies of a Near-Maximum Storm at St. Louis: *Introduction.* W. W. HORNER: *Depth-Area Relationship for an Unusual Storm in St. Louis.* HARRY KROEGER AND HENRY I. STEWART: *Probable Maximum Flood Flow from a Small Watershed.* J. K. BARTLETT AND T. G. PFIFFNER. Civ. Eng. **10:** 230 (Apr. '40). On Aug. 25, '39 an all-time high of 5.02″ was recorded between 4:35 and 5:35 A.M. High spot intensities that occurred for durations of 15 min. to an hour or more are about 50% greater than those shown on Yarnéll's 50-yr. frequency curve. Storm is a near max. for upper Mississippi Valley. Data are presented showing relation of rainfall depth to area covered and it is shown how the type of information developed may be applied to determine probable stream-flow hydrograph for a rural drainage basin of 4 sq. mi. Application of channel-storage method to main channel system might have been further refined by development of stage-discharge and stage-storage graphs, separately for rising and falling sides of hydrograph. This type of application is much more sensitive to best choice of Manning *n* coefficient for channel reach adjacent to control section. An *n* of 0.030 was used. Paper presents problem of finding hydrograph of stream-flow through control section just above proposed reservoir, computing flood flow from infiltration and channel storage. When this problem is solved it is a simple matter to determine necessary capacity of spillways. By system of proportioning between mass curve of inflow and storage and discharge curves, mass curve of outflow through control section was drawn and from this hydrograph of discharge was plotted. Interesting thing about computations is large amount of storage in channel system at peak of outflow hydrograph. Very few computations for flood flow on small watersheds have been made, and it is felt that this procedure may help in design of small dams and spillways.—*H. E. Babbitt.*

A Portentous Drought in the Making. H. P. GILLETTE. W. W. and Sew. **87:** 38 (Jan. '40). Measurements of varves in stratified rock in Wash. and Calif. indicate definite long-range cycles of rainfall. These indicate 1964 as dryest year since Cheops. Effects on semi-arid regions will be very severe. Recent rainfall and river flow records tend to corroborate evidence of varves. Res. behind Hoover Dam may go entirely dry within 25 yr. Author suggests that hydraulic engineers should pay more attention to such evidence.—*H. E. Hudson, Jr.*

Water Service Men Fight Drought on Many Fronts. ANON. Railway Age **108:** 3: 160 (Jan. 20, '40). Climaxing a year of abnormally low rainfall, many parts of the country have recently experienced driest fall season in their climatological history, reported conditions being particularly severe in Southwest, plains states east of Colo., and South. Railroads operating in Okla., Tex., N. M., and Ariz. report water shortages. Precipitation in Iowa, Neb., Kans., and Mo. reported from 25% to 55% of normal. Ky., Ark., La., Miss. and Ala. experienced a deficiency after Jun., ranging from 50% to 56%. Dry weather which caused serious trouble in W. Va. and Ohio was not reported. Emergency measures were taken by many railroads to prevent water shortage or deteriorated quality interfering with train movement. Low stream stage increased troubles caused by acid coal mine drainage. Salt water from the

Gulf of Mexico backed up in the Mississippi R. for over 200 mi. Many reservoir supplies went entirely dry which necessitated hauling water, double tanking on locomotives, or, in some cases, temporary pumping stations. Some relief has occurred since Jan. 1 but conditions as of Feb. 1 were still subnormal. —*R. C. Bardwell.*

Water Supply on the Upper Salt River, Arizona. JOHN GIRAND. Proc. A. S. C. E. **65:** 1675 (Dec. '39). Salt River rises at elevation of 10,000 ft. in White Mountains of Arizona and drops more than 7,000 ft. through isolated, heavily timbered, sparsely populated regions, flowing into Roosevelt Res. near central part of Arizona. Impounded water is used for irrigation and power development, for which principal market is Phoenix. Recent increases in power demand have necessitated investigation of power development possibilities along Upper Salt River above Roosevelt Res. Hydrograph of estimated flows at project site at Chrysotile has been constructed from Jan., 1881 to Sep. '36. Since neither mass diagram nor duration curve based on hydrograph will give storage requirements for any sequence of years, desired information was secured by construction of hydrograph for next 20 yr., based on certain requirements of probability and sequence from past records. Number of different sequences obtainable is enormous. Probably sequences can be selected only by judgment. There is a large field open for investigation in the realm of direct prediction of future flows. Discovery of existence of an "11-yr. cycle" on watershed, and use of information given by the California Sequoias, opened field for long-time predictions of future weather and run-off. Interesting disclosure obtained from 1,200-year records is the recurrence of a 5-year drought sequence at 300-year intervals. General arid condition of climate during Middle Ages was also revealed. Economical storage requirements were computed by mass-diagram method from probable future hydrograph, drawn on basis of data collected.—*H. E. Babbitt.*

Reinforcing Water Economy of Erft Basin by Impounding Reservoirs. ALFRED STRECK. Deut. Wasserwirtschaft **34:** 175 (Apr. '39). Hilly region of upper and middle Erft, being under lee of Hohe Eifel, which sheds most of its rain on western slope, is characterized by unduly low rainfall. Area of basin is about 1600 sq. km. and length of river, about 100 km. In dry seasons, acute shortage develops in supply available for irrigation. Yet, so recently as 1859, lower Erft, where shortage is now most keenly felt, was threatened with degeneration into a swamp. A Genossenschaft was organized thereupon to cope with situation, and it has done so with notable success. District is now well drained and large areas are being adequately irrigated. Of some 4000 ha. needing irrigation, 2500 ha. are equipped with all necessary facilities through competent irrigation associations. As demand for water in dry seasons now outstrips supply, these associations are occasionally at loggerheads. Considerable areas of grass lands in recent years have had to be broken up, because menace of water shortage renders livestock too hazardous. Industrial and municipal undertakings have not only drawn heavily upon the Erft's none too abundant water resources, but have also created pollution problems. As only way out for Erft district is seen in construction of large res. to impound,

as available, sufficient surplus water to make good deficiency (reckoned at about 10 cu. hectometers) of a dry season. Details are given of proposed works, with rentability estimates. Total cost is reckoned at 7,000,000 RM. Resulting increase in hay harvest is regarded as equivalent to an addition of 500 ha. to present land area.—*Frank Hannan.*

Development of Italy's Water Powers. *Hydrographic Service Bulletin Nos. 10 and 11.* (*Review*) Ann. Lavori Pub. (Rome) **77:** 1079 (Oct. '39). Power stations listed number 862, with nominal h.p. of 3,749,645 and installed kw. capac. of 4,666,814; respective increases for the year being 170,000 h.p. and 291,000 kw. Res. with capac. of 500,000 cu. m. and greater, number 101, with total capac. of 1616 million cu. m. representing potential energy of 1670 million kw. hr. Developments under construction at end of '38 are estimated at 633,000 h.p. List given of individual plants with respective technical data. Minister of Public Works adds commentary on present and prospective developments.—*Frank Hannan.*

Italian Watershed Characteristics. *Issued as Publication No. 17, Second Edition, of the Hydrographic Service, 435 pp. l. 40.* (*Review*) Ann. Lav. Pub. (Rome) **77:** 1080, (Oct. '39). First edition, issued in '34, covered all recorded observations through '32. In present edition, data are extended to end of '35, with other additions and improvements. Work is divided into 3 parts. Part I deals with 26 watersheds which are typically important. Gives for every year, for as far back as reliable observations extend, max., min. and mean recorded water levels and levels equaled or exceeded, upon, respectively, 10, 91, 182, 274, and 355 days of each year. In first edition these data were given for each of 250 measuring stations then existing, but only from date of institution of Hydrographic Service; they are now given for watersheds of major importance and are carried backwards to include all reliable data ante-dating Service. Part II gives for each of 326 measuring stations now in operation, classified into hydrographic areas, principal physical watershed characteristics: (1) total drainage area contributing; (2) percentage permeability; (3) nature of vegetative covering; (4) installed res. capac.; (5) altitudes, max. and min.; (6) elevation of zero altitude above sea level; (7) max. and min. recorded stream flow, with dates, for as far back as reliable records extend; (8) area under irrigation; and (9) hydroelectric power installed under govt. concession. Sketch maps are supplied indicating exact location of measuring stations. 3 tables are added. Table I gives mean monthly and annual stream flow (cu. m. per sec.) for every month and year since observations began. Table II gives rainfall, runoff, apparent loss, max. and min. stream-flow, flow available respectively for 10, 91, 182, 274, and 355 days. Table III gives recapitulative values, covering entire period of observation: of max. and min. stream flow for each month in year and for year; stream flow, runoff per sq. kw., and hydrologic balance; rainfall, runoff, and apparent evaporative loss in ave. year. Part III, represents most striking innovation. Is devoted to matter carried in suspension by 36 of principal rivers. For each year of observation, monthly and annual values are given for mean specific turbidity and for total suspended matter. Annual total is also given expressed

as tons per sq. km. of watershed area. Not only is information in publication vast in extent, but also presented in a form immediately suitable for use of engineer.—*Frank Hannan.*

The Determination of Evaporation from Land and Water Surfaces. C. W. THORNTHWAITE AND BENJAMIN HOLZMAN. Monthly Weather Rev. **67**: 4 ('39). Evaporation in in. per hr. is $E = [0.0274\ P\ (q_1 - q_2)(u_2 - u_1)]/(T + 459.4)$, where q_1 and q_2 are grams of water per kg. of air at 2′ and 28.6′, respectively, above ground; u_1 and u_2 are wind velocities at those levels, P is barometric pressure in in. mercury and T is temp. in °F.—*C. A.*

Some Economic Aspects of the Upland Watershed Lands of the Western United States. MONT H. SAUNDERSON. J. Land & Pub. Util. Econ. **15**: 480 (Nov. '39). Western states afford unique illustration of interdependence of land uses and demonstrate how profitable use of one resource is dependent upon proper management of another form of land. Snow surveys show that approx. 200 million acres of land above 7000 ft. elevation yield most of water used for agriculture in 11 western states, annual precipitation 50″ largely snow. Any material change in condition of watershed lands affects water yield. Change in density and type of plant cover may alter time of runoff, vol. of runoff, influence quantity of silt and detritus material. Cost of water to users was represented by cost of necessary water works, any value of water above this cost capitalized into value of irrigated land or water shares. Method of measuring value of water, sum of capital values of lands and water shares; deduct cost of water works structures, raw land and preparation of land for irrigation. Resulting figure, 1930 census, equals about 2½ billion dollars, about $12.50 an acre for high watershed lands. Grazing and timbering tend to compete with watershed use, likewise land is under different ownerships, all tending to interfere with exclusive use. Value of land for water above timbering and grazing predicated upon public ownership. Analysis of capital values, income, and number of farm families show importance of maintaining watershed. Potential damage to range and timber land small in contrast to potential damage from impairment of watershed value.—*Samuel A. Evans.*

Re Pennsylvania Water & Power Company Order of Federal Power Commission. Pub. Util. Fort. (Jan. 4, '40), P. U. R. **31**: 1. Commission issued order directing respondent, Penna. Water and Power Co. to appear and show cause why appropriate proceedings should not be instituted against it for operating and maintaining the Holtwood Dam and Power Plant on the Susquehanna R. without license granted pursuant to Federal Power Act. Respondent denied river was navigable and averred Federal Power Commission without jurisdiction. Two issues: (1) Whether Susquehanna is navigable at site of Holtwood Dam, (2) what would constitute an order "appropriate, expedient, and in the public interest" in the premises. Congressional definition of "navigable waters": ". . . those parts of streams . . . which either in their natural or improved condition notwithstanding interruptions between navigable parts of such streams or waters by falls, shallows, or rapids compelling land carriage, are used or suitable for use for the transportation of persons or property in

interstate commerce, including therein all such interrupting falls, shallows, or rapids. . . . " Crucial test of navigability of a stream is its susceptibility of use as a highway of commerce rather than its actual use. Characteristics of a stream determine its susceptibility to navigation, however all facts pertaining to susceptibility of navigation vanish when there is evidence of actual commercial navigation. Having been used as an avenue of commerce, Susquehanna was and remained navigable water of U. S., and character was not changed by any subsequent economic or geographic developments resulting in disuse for navigation; river within constitutional control of Congress. Control can only be relinquished by Congress. It is within the discretion that the Commission, since the river is navigable, require a project to be operated under a license and so ordered in this case. Suggested Commission might require removal of dam or reconstruction; however, nothing in the record showing such would be expedient or in public interest.—*Samuel A. Evans.*

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